INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of “sectioning” the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.
Ko, Wansuk Matthew

AUDITOR'S INCENTIVE, LEGAL LIABILITY AND REPUTATION UNDER INFORMATION ASYMMETRY

The Ohio State University Ph.D. 1985

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106
AUDITOR'S INCENTIVE, LEGAL LIABILITY AND REPUTATION
UNDER INFORMATION ASYMMETRY

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in the Graduate School of The Ohio State University

By
Wansuk Matthew Ko, M.B.A.

The Ohio State University
1985

Reading Committee:
Thomas J. Burns
Daniel L. Jensen
Richard A. Jensen
Gordon M. Clark

Approved By
Thomas J. Burns
Advisor
Faculty of Accounting
To My Parents
ACKNOWLEDGMENTS

I would like to express my appreciation to the many people who have contributed to the successful preparation of this dissertation. I especially thank my reading committee, Professors Thomas Burns, Dan Jensen, Richard Jensen and Gordon Clark. They have given me the advice and encouragement needed to complete this work. In particular, I gratefully acknowledge the thoughtful guidance and support that my advisor, Professor Thomas J. Burns, has persistently provided me during my Ph.D. program.

I also thank Professor Ernest Hicks who gave freely of his time and who provided many helpful suggestions, and Professor Stan Baiman of Carnegie Mellon University whose critical comments helped to improve this research. I would also like to thank the members of The Ohio State University Accounting Research Colloquium for their helpful comments in the early stage of the study, especially my colleagues, Rick Young, Duane Moser and Bill Cready who were always willing to listen and help. I also thank John Nerbonne for his editorial comments, and Soonjo Hong and Woonkwang Yeo for their suggestions in developing the numerical example and its computer algorithm.

Above all, I thank my wife, Jong-Yo, for her cheerful perseverance and support throughout my graduate program.
VITA

March 5, 1953 . . . . . . . . . . . . . . . . . . . . . . . . . Born - Seoul, Korea

1975 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . B.A. (Business Administration),
Seoul National University,
Seoul, Korea

1977 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . M.B.A.,
Seoul National University

1980 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . M.B.A.,
University of Santa Clara,
Santa Clara, California

1980-1985 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Graduate Teaching Associate,
Faculty of Accounting,
The Ohio State University,
Columbus, Ohio

FIELDS OF STUDY

Major Field: Accounting

Studies in Economic Theory

Studies in Statistics
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF GRAPHS</td>
<td>ix</td>
</tr>
<tr>
<td>Part</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>II. PAST RESEARCH</td>
<td></td>
</tr>
<tr>
<td>1. Literature Review</td>
<td>4</td>
</tr>
<tr>
<td>2. Agency Theory of Demand for Auditing</td>
<td>11</td>
</tr>
<tr>
<td>2.1. The Agency without Demand for Auditing</td>
<td>11</td>
</tr>
<tr>
<td>2.2. The Agency in Demand for Auditing</td>
<td>14</td>
</tr>
<tr>
<td>III. AUDITOR INCENTIVE AND LEGAL LIABILITY.</td>
<td>18</td>
</tr>
<tr>
<td>1. Assumptions and Definitions</td>
<td>19</td>
</tr>
<tr>
<td>2. Individual Decision Behaviors</td>
<td>23</td>
</tr>
<tr>
<td>2.1. The Owner</td>
<td>23</td>
</tr>
<tr>
<td>2.2. The Auditor</td>
<td>27</td>
</tr>
<tr>
<td>3. Propositions</td>
<td>30</td>
</tr>
<tr>
<td>4. Example</td>
<td>42</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Uniform and Mixed Equilibria</td>
</tr>
<tr>
<td>2.</td>
<td>An Auditor's Expected Profit Function</td>
</tr>
<tr>
<td>3.</td>
<td>Different Cases for an Auditor's Expected Profit Function</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The Effects of the Standard</td>
<td>82</td>
</tr>
<tr>
<td>2.</td>
<td>The Effects of Audit Cost</td>
<td>86</td>
</tr>
<tr>
<td>3.</td>
<td>The Effects of Risk Aversion</td>
<td>90</td>
</tr>
</tbody>
</table>
## LIST OF GRAPHS

<table>
<thead>
<tr>
<th>Graph</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Effect of the Standard on $z^*$'s.</td>
<td>83</td>
</tr>
<tr>
<td>2. The Effect of the Standard on $X_n^*$</td>
<td>84</td>
</tr>
<tr>
<td>3. The Effect of the Standard on $e$</td>
<td>85</td>
</tr>
<tr>
<td>4. The Effect of Audit Cost on $z^*$'s.</td>
<td>87</td>
</tr>
<tr>
<td>5. The Effect of Audit Cost on $X_n^*$</td>
<td>88</td>
</tr>
<tr>
<td>6. The Effect of Audit Cost on $e$</td>
<td>89</td>
</tr>
<tr>
<td>7. The Effect of Risk Aversion on $z^*$'s</td>
<td>91</td>
</tr>
<tr>
<td>8. The Effect of Risk Aversion on $X_n^*$</td>
<td>92</td>
</tr>
<tr>
<td>9. The Effect of Risk Aversion on $e$</td>
<td>93</td>
</tr>
</tbody>
</table>
Agency research in accounting has broadened its scope by incorporating into the classical two-person agency model (i) auditing (Ng and Stoekenius [1979], Evans [1980]) and (ii) the auditor as a second agent of the owner (principal) of the firm (Noel [1981], Antle [1982]).

The research has suggested that any agent's compensation scheme should be based on data whose values are affected by the agent's effort and are jointly observable by the agent and the principal, in order to reduce the agent's moral hazard problem. However, audit fees are generally based on the number of audit hours, which are not observable by the owner of the firm. Is not this observation inconsistent with agency theory? Perhaps auditors shouldn't be analyzed under this theory: are they perhaps not rational in that they are not utility maximizers as assumed in the agency literature?

Motivated by such questions, this paper will demonstrate that, where the auditor is a utility maximizer, basing the audit fee contract on the number of audit hours is still consistent with agency theory. This is done by examining two important aspects of auditors, their legal liability and their professional reputation: these aspects have
not previously been incorporated explicitly and thoroughly in an agency model with the auditor.¹

The paper will construct an auditing model which borrows insights from existing studies in law and economics, Simon (1980) among others, to address how the two aspects impact the auditor's agency problem. The model will demonstrate that professional auditing standards and the auditor's legal liability provide an economic warranty implicitly offered by the auditor to the owner of the firm, and that the auditor's professional reputation serves as a collateral bond ("something pledged by the auditor"). Warranties and collateral bonds are well-known (costly) economic arrangements used as a scheme to reduce problems arising from the existence of asymmetric information between the contractual parties.

Though these legal/economic arrangements help to reduce the auditor incentive problem, they do not perfectly cure the problem. In the audit service market, there exist not only auditors who exercise due professional care but also ones who fail to do so. This phenomenon also will be examined and its reason will be explained through the model. Indeed, the audit quality problem has become an important issue. The existence of audit failures allegedly due to auditors' lack of professional care has recently attracted increased public concern about audit quality:

[F]aith has been eroded lately through a series of incidents in which some of the most elite accounting firms have blessed a financial statement on the eve of disaster.... The numerous incidents--or at least a public perception that auditors are
wrong too often—has made the accounting profession a new target of inquiry. (The New York Times, May 13, 1984) (Emphasis added.)

The auditing model to be constructed will also, at least partially, explain this phenomenon.

Part 2 reviews the literature relevant to the study and examines how auditing is demanded in the presence of asymmetric information in an agency based on the findings of past research, and Parts 3 and 4 analyze how the generally accepted auditing standards, audit costs and owners' risk preferences affect the effort level of auditors who face potential litigation. In particular, Part 3 deals with a situation where audit services are sold in a perfectly competitive market but with imperfect user information, and Part 4 is concerned with a monopolistically competitive market where audit services are distinguishable due to the auditors' professional reputations. Both Parts also draw policy implications.
PART II
PAST RESEARCH

1. Literature Review

The problem of asymmetric information in the context of an agency has been formally analyzed in information economics and in accounting. Early studies include Wilson (1968) and Ross (1973) which discuss the agency information problem where the information system is the agency's outcome (result of operations) itself, and where an individual's action does not enter the individual's utility function. Stiglitz (1974) makes the same informational assumptions, but interprets action as effort which has negative marginal utility.

The agency paradigm has recently been developed in managerial accounting. Demski and Feltham (1978) model optimal managerial responses to exogenously imposed incentive structures in agency theory. Holmström (1979) considers the moral hazard problem and the role of asymmetric information in an agency setting. He derives a necessary and sufficient condition for imperfect information to improve on contracts based on the agency's outcome. He also characterizes the optimal use of such information. Baiman and Demski (1980) examine the
role of information in a firm's performance evaluation and control system using the dichotomy of decision-influencing and decision-facilitating information. Their study of decision-influencing information focuses on the familiar managerial accounting constructs of variance procedures, conditional investigation of variances, and responsibility accounting in the basic and extended agency framework.

The agency information problem is later introduced in a financial accounting context. Gjesdal (1981) examines stewardship demand for financial information within a generalized agency model, derives sufficient conditions for information to be valuable, and characterizes a ranking of information systems.

All the above research assumes that an agency's outcome or a firm's profit is observable not only by the agent (manager) but also by the principal (owner) and, therefore, does not create the demand for auditing.

The analysis of the asymmetric information problem in accounting is extended as the auditing phenomenon is incorporated into the model. Ng and Stoeckenius (1979) develop a general agency model with auditing and establish conditions necessary for management to report truthfully. They find that truthful reporting can be induced by auditing under a certain set of assumptions and derive the downward-sloping audit demand curve in a simplified setting. Evans (1980) incorporates (perfect) audit technology into a two-person agency model and endogenously derives the optimal form of auditing contracts. However, Ng and
Stoeckenius (1979) and Evans (1980) focus on an audit technology rather than on an auditor as an economic agent.\footnote{4}

Noel (1981) and Antle (1981, 1982) model an auditor as an economic agent in an agency framework. Noel (1981) constructs a three-person, micro-level model of auditing by adding an auditor as a second agent of the owner to the classical two-person agency model. He is basically interested in which information structures are necessary and/or sufficient for auditing to have value.\footnote{5} If the owner had no information other than the financial statements and audit report, Noel indicates that the auditor cannot be controlled and would not supply any audit effort so that there is no meeting of supply and demand for auditing. On the other hand, if the owner is given an imperfect signal (something other than the financial statements and audit report) about the agency's true outcome, the audit services become valuable because the owner can control the auditor's behavior and the auditor will provide some effort at any audit price. But, as Noel admits, we must specify more precisely what the imperfect signal will be. Finally, he maintains that, while the owner can acquire the outcome information from either agent, the information can be acquired from the auditor with a reduction in the expected cost of the management compensation contract, and that it is the reduction in the cost of inducing truthful reporting which makes audit services valuable.

Antle (1982) also recognizes the motivational problems of rational human auditors. The auditor is explicitly modeled as a strategic
player maximizing expected utility, and his role is defined as the production of stewardship information (i.e., verification of the manager's financial report). He focuses on the existence of a dominant Nash equilibrium of the game strategies in a three-person game theoretic agency setting and the existence of a contract which induces the manager and the auditor to report faithfully to the owner of the firm.

However, the above mentioned auditing research in the agency framework does not ask such questions as why the audit fee contract is based on the amount of audit hours (which are not observable by the principal) or what costs the auditor bears that the manager does not. Consequently, the previous research has not explicitly considered the auditor's legal liability.

The existence of auditor's legal liability and an effective legal system seems to be a fundamental reason to view the audit market as existing in an environment of asymmetric information between the auditor and the owner. In fact, Akerlof (1970) remarks that, in a market where buyers use market statistics to judge the quality of prospective purchases, there is an incentive for sellers to market poor merchandise since the returns for good merchandise accrue largely to the entire group rather than to the individual seller. This results in a phenomenon analogous to Gresham's law, so that, in a case with more continuous grades of goods, no market can exist unless there are some
institutions such as guarantees, chains, and so on, in order to counte­
eract the adverse effects of quality uncertainty.

The economic analysis of liability systems was initiated by Brown
(1973), and followed by Diamond (1974). 7 Diamond (1974) shows that,
when litigation is costless, all participants in the risky activity
elect to become non-negligent for a nontrivial range of values of the
due care standard (Uniform Equilibrium). In contrast, others find
that, when litigation is costly, there will be both negligent and non-
negligent people (Mixed Equilibria). In particular, Ordover (1978)
demonstrates that, with the rule of negligence-contributory negligence
and costly litigation, the willingness of some people to disobey the
due care standard crucially determines the effectiveness of the
liability rule in securing a socially more desirable allocation of
resources toward accident avoidance. 8 With the negligence rule and
costly litigation, Simon (1981) shows that for a wide range of due-care
standards there exist mixed equilibria in the market for the product
which may cause an accident to its consumers. 9

The legal liability issue has just begun to attract attentions
from accounting researchers, such as Antle (1981), DeJong (1983) and
Nagarajan (1984), among others, who examine the legal liability of
auditors in a formal agency framework. Antle (1981) examines effects
of the owner's litigation policy on the auditor's incentive to inves­
tigate the manager's activity, and focuses on what condition is
necessary for the owner to litigate and whether optimal litigation
exists. However, his analysis does not include the examination of the actual litigation process beyond the necessary condition for litigation. Also, his litigation concept is different from what is generally held in the audit profession in that, in his model, the owner never sues the auditor unless there is a discrepancy between the manager's report and the auditor's report. Then, while Antle (1980) does not mention how the owner's litigation probability will be determined, the owner may sue the auditor with a certain probability and obtain the court's report about the auditor's effort level and the firm's outcome.

DeJong (1983) and Nagarajan (1984) essentially focus on the efficiency issue of the liability systems. DeJong (1983), interested in the normative issue of the form of the auditor's legal liability to investors under section 11 of the Securities Act of 1933, develops a two-person agency model. In the model, the prudent man (principal) who manages his own property has an investment plan to purchase a firm for a price that is determined by the firm's current-state-dependent future cash flows. Being unable to observe the states, the prudent man hires an auditor (agent) to perform an audit and to issue a report indicating which state has occurred. The prudent man purchases the firm for the price determined by the auditor-reported state only when the auditor's report agrees with the existing owner's report. The auditor is legally liable for the prudent man's investment loss due to an incorrect audit report. DeJong (1983) proposes that under the strict liability rule
the optimal damage award is greater than zero but less than the prudent man's loss and that, when an ex-post observation, even if imperfect, is possible, a negligence liability rule is strictly pareto-superior to the strict liability rule. But he ignores the professional standard concept so that his negligence rule becomes very unusual one. His model limits the scope of auditing to providing service for the buyer of a firm.

Nagarajan (1984), using Shavell's (1982) model, investigates the incentive effects of strict liability and negligence and compares the two systems with respect to their Pareto superiority in various cases partitioned based on whether litigation is costless, whether litigants are risk averse, and whether insurance is available. In particular, he examines a situation where the court's verification of the audit efforts is imperfect and all litigants are uncertain about the litigation outcome.

But none of the three studies discussed above considers the audit market as a whole where multiple owners and auditors interact, nor does any consider the effects that the litigation results may have on the auditor's professional reputation and, in turn, on his work incentive.

This study considers the market for audit service where an auditor has professional contracts with multiple clients, is subject to legal liability in the presence of auditing standards, and is concerned about his professional reputation. Adapting models from law and economics into an auditing environment, this study will analyze the effect of the
auditors' legal liability on quality of the audit (which is defined as the level of care exercised by the auditor), and it will draw some conclusions and present implications for auditing. The focus will not be a comparison of liability systems (even though it will be made where appropriate), because auditors are under the negligence system.

First, the study will deal with a situation where audit services are sold in a perfectly competitive market but with imperfect user information. Next, it will consider a monopolistically competitive market where audit services are distinguishable due to the auditors' professional reputations.

2. Agency Theory of Demand for Auditing

Before considering the main model, an examination is made of how auditing is demanded in the presence of information asymmetry in an agency.

2.1. The Agency without Demand for Auditing

In the agency model of the firm, an agency relationship arises when one or more individuals (the principal) hire another person (the agent) and delegate to him the rights and responsibilities of decision making with regard to the investment made by the principal. The agent, motivated by his own self-interest, privately takes an action and the action taken, together with a random state of nature, determines the payoff shared by the principal and the agent. The agent is better
informed about his own efforts and the state realization than the principal. This asymmetry of information between the two individuals becomes a source of the agency problem, commonly called the moral hazard or incentive problem. In order to solve the problem, though not completely, the principal attempts to write a contract with the agent so as to induce the latter to select an action which is consistent with the principal's interests. A simple remedy to the incentive problem is to invest resources into monitoring of actions and then to put the information produced by the monitoring to use in the contract. However, since this remedy is generally infeasible or prohibitively costly, an alternative remedy is to find a jointly observable but imperfect monitoring signal on which to base the contract (Holmström, 1979).

When the payoff is jointly observable and signals (imperfectly) the agent's efforts, this is the base for the contract. Then, the agency problem is formally represented as follows:

\[
\begin{align*}
\text{Max } & \int_{s \in J} \phi(s) \cdot U[w(a,s) - I(w(a,s))] \, ds \\
\text{subject to: } & EV(I,a^*) = \text{Max } \int_{a \in A} \phi(s) \cdot V[I(w(a,s)),a] \, ds \\
\text{and } & EV(I,a^*) \geq \bar{V}
\end{align*}
\]

where \( U(\cdot) \): principal's utility function,
\( V(\cdot,\cdot) \): agent's utility function,
\( EV \): agent's expected utility,
\( I(*) : I(*) \in J \), set of all possible incentive contract functions representing the agent's share of the payoff,

\( \phi(*) : \) probability function,

\( w(*, \cdot) : \) payoff function,

\( \overline{V} : \) constant representing agent's minimum utility

\( a : a \in A, \) set of all feasible agent's actions,

\( s : s \in S, \) set of all possible random states of nature, which are not revealed to the agent when \( a \) is chosen.

Equation (2.1) represents the principal's objective of designing an incentive contract which is agreeable to the agent and maximizes his own expected utility. His utility is a function of his share of the payoff.

Equation (2.2) represents the agent's objective of selecting his action to maximize his expected utility. His utility is a function of his share of the payoff and the action chosen. The constraint represented by equation (2.2) is referred to as the incentive compatibility constraint.

Equation (2.3) represents the agent's minimum utility constraint which is assumed to be determined by the competitive labor market. If equation (2.3) is not satisfied, the agent will find himself better off not in the principal's employ.

The solution to the above agency problem has been referred to as a second best solution, which trades off some risk-sharing benefits for provision of incentives (Holmström, 1979).
A very important assumption made in the above model is that the firm's payoff is perfectly observable to both the agent and the principal. Accordingly, there is no incentive for the principal to hire a monitor to examine whether the description of the payoff truthfully reflects the payoff realized. There does not arise any demand for auditing in the above model. This model, though, has made a significant contribution to examining the relationship between the firm's information systems, its employment contract and the welfare of its members in the managerial accounting context.

2.2. The Agency in Demand for Auditing

Most of the asymmetric information studies focus on one aspect of information asymmetry: the action selected by the agent (the manager of the firm) unobservable to the principal (the owner of the firm). However, as Ng (1978) points out, in general, not only the manager's action but also the payoff (determined by his action and the random state of nature) is unobservable to the owner. Because of this, the manager of the firm is required to provide some retrospective description of the firm's payoff, i.e., financial statements. Furthermore, since these financial statements represent a main source of information about the firm's payoff to the owner (shareholder), the management compensation scheme tends to be based on these statements. However, this kind of compensation scheme often leads to nontruthful reporting and the shareholders are hardly able to motivate and to achieve optimal
risk sharing. About the reason for this phenomenon, Ng and Stoeckenius (1979) state:

\[\text{When the manager's actions, the states of nature and the firm's payoff are unobservable to the owner, the manager has little incentive to expend effort and adopt optimal risk-sharing actions if he can guarantee himself a higher or equal utility level by falsifying the report. (p. 8)}\]

As a technology to overcome this difficulty, auditing is demanded by the agency. The shareholder will want an auditor to audit the manager's financial report and to render an opinion about whether or not the manager's report faithfully reflects the firm's payoff. The agency model without auditing is extended by Ng and Stoeckenius (1979) to include the audit as a technology for detecting whether the manager's report is in error by reporting a payoff different from the actual one. The shareholder is assumed to know the payoff function, \(w(a,s)\) and the manager's action set, \(A\). He cannot observe the state, \(s\), and the actual payoff, \(w\), even after their realizations. Instead he receives a reported payoff number, \(y = f(w(a,s))\), prepared by the manager with full control over the reporting function, \(f(\cdot)\). An auditor is hired to exercise an audit level, \(\theta\), which does not always identify accurately the magnitude of the firm's payoff.\(^{15}\) If the audit opinion reports that no error has been detected, the manager's remuneration will be a function of the reported payoff, \(I(f(w))\). Otherwise, the manager is penalized and his remuneration will be \(I(f(w) - P(k(w)))\), where \(P(\cdot)\) is a penalty function based on the size of the error, \(k(w)\). Then, the Ng & Stoeckenius' agency model with auditing is formalized:\(^{16}\)
\[
\begin{align*}
\text{Max} & \quad \int \phi(s) \left[ U[w(\cdot, \cdot)] - I[w(\cdot, \cdot) + k(w(\cdot, \cdot)) - P(k(w(\cdot, \cdot))) - q\theta + P[k(w(\cdot, \cdot))] \cdot \\
& \quad \text{subject to:} \\
& \quad \text{EV}[I,a*,k*] = \end{align*}
\]

\[
\begin{align*}
\text{Max} & \quad \int \phi(s) \left[ V[I[w(\cdot, \cdot) + k(w(\cdot, \cdot))] - P[k(w(\cdot, \cdot)), a] \cdot \\
& \quad \text{subject to:} \\
& \quad \text{EV}[I,a*,k*] \geq \bar{V} \end{align*}
\]

where \( U(\cdot), V(\cdot, \cdot), EV, \bar{V}, I(\cdot) \in J, w(\cdot, \cdot), a \in A, s \in S \): as defined earlier,

\begin{align*}
P(*) : & \quad P(*) \in \Gamma, \text{ set of all possible penalty functions,} \\
f(*) : & \quad \text{manager's reporting function,} \\
k(*) : & \quad k(*) \in K, \text{ set of all possible error functions;} \\
& \quad k(w) = f(w) - w, \\
q : & \quad \text{price per audit effort unit,} \\
\theta : & \quad \text{effort level of audit,} \\
\phi[D|k(w), \theta] : & \quad \text{conditional probability of detecting that} \\
& \quad \text{the report is in error, given } k(w) \text{ and } \theta, \\
\phi[-D|k(w), \theta] : & \quad \text{conditional probability of not detecting that} \\
& \quad \text{the report is in error, given } k(w) \text{ and } \theta.
\end{align*}

Equation (2.5) represents the manager's decision problem of selecting \( a \) and \( k(*) \) given \( \theta, I(*) \) and \( P(*) \) to maximize his expected utility (the incentive compatibility).
Equation (2.4) represents the shareholder's problem of deciding on the managerial remuneration function, I(·), the penalty function, P(·), and the audit level, θ, to maximize his own expected utility subject to the incentive compatibility and the minimum utility constraints.

The above agency model with auditing generates important results: (i) there exists a <P(·), I(·), θ> triplet that induces the manager's truthful reporting; (ii) auditing, if costless, allows an owner to provide incentive and to share risk with the manager as if he were able to observe the firm's payoff; and (iii) the demand function of a (risk-neutral) owner for audit effort level is downward sloping. However, as Baiman (1979) recognizes, this model ignores the motivational problems of rational human auditors:

[T]his [model] is about the value of audit technologies not the value of auditors.... If the owner hires an auditor to make sure that the manager is not cheating him, how is the owner assured that the auditor is not also cheating him by not delivering the agreed upon level of auditing services? This is an important issue since auditing services are not observable by the owner. (p. 29) (Emphasis added.)
PART III
AUDITOR INCENTIVE AND LEGAL LIABILITY

The owner of the firm hires an auditor as a second agent who is expected to attest to the assertions made by the manager of the firm, thereby inducing the manager to report truthfully to the owner.18 Thus, there arises an agency problem between the owner and the auditor similar to the one between the owner and the manager: how to motivate the rational auditor to deliver the contracted level of audit services where these services are not observable by the owner. As mentioned earlier, agency theory has suggested that the agent fees be based on data jointly observable by the agent and the principal to minimize the agent's moral hazard problem. However, auditor fees are generally based on the audit hours, which are not observable by the owner. Is it a phenomenon contradictory to what agency theory has suggested? Or should the assumption of the auditor's own utility maximization be thrown out? What costs does the auditor (but not the manager) face that make it easier to motivate the auditor (rather than the manager)? Have some important variables explaining the phenomenon been ignored?
Motivated by these questions, and taking insights from existing studies in law and economics, Simon (1981) among others, this part will explicitly model the auditor's legal liability, which is viewed as an institution that provides an implicit warranty contract and examine how it effectively alleviates the auditor incentive problem.

The auditor's legal liability will be defined in the following way: when the audited financial statements (audited reports) are found to deviate materially from generally accepted accounting principles (GAAP), the auditor, where due skill and care are not exercised, is liable for the owner's loss due to the material misstatement. This is based on Statement on Auditing Standards (SAS) No. 16, which says:

[Under generally accepted auditing standards the independent auditor has the responsibility, within the inherent limitations of the auditing process, to plan his examination to search for errors or irregularities that would have a material effect on the financial statements, and to exercise due skill and care in the conduct of that examination .... An independent auditor's standard report implicitly indicates his belief that the financial statements taken as a whole are not materially misstated as a result of errors or irregularities. (Emphasis added.)

1. Assumptions and Definitions

An auditor is assumed to be an economic agent maximizing his own utility (See Noel [1981], Antle [1982] and DeAngelo [1981]). The audit service is assumed to be rendered in a perfectly competitive market. Perfect competition means that: 1) individual auditors with identical cost conditions are price-takers for their services, and 2)
the audit services rendered are homogenous in the eyes of the owner of the firm so that the owner is unable to distinguish between audit services not only prior to the writing of the audit contracts but also after the completion of the audit service. In other words, the owner cannot exactly determine whether his audit service is or is not of standard quality, where the audit of standard (substandard) quality is defined as the audit completed with (without) the auditor's due care. However, he is assumed to have a good estimate of the proportion of audit services which are substandard. This determines the owner's prior probability of receiving a substandard audit service, which will be denoted by e.

After an audit service is completely performed, whether or not it is of standard quality, the audited reports may be found to be materially deviant from GAAP in a later period. For example, the net income of a firm in an audited report may be discovered to be materially different from the net income according to GAAP. Such a discovery occurs for various reasons. The same auditor, or more likely, a different auditor may discover a material error in the (previous) audited statements while doing regular audits in later periods. Other ad hoc occasions, such as bankruptcy or tax irregularity, accompanied by a thorough investigation of the firm's financial records may result in such a discovery. These events are assumed to occur randomly: they occur stochastically with a probability function depending on the size of extant GAAP deviation and the level
of audit care (efforts), for example, the number of audit hours worked.\textsuperscript{21}

Let $f(z|x)$ denote the conditional probability density function of GAAP deviation of size $z$, $z \in \mathbb{Z}$, being discovered in an audited report after the audit was completed with a care level, $x$, $x \in X$, where $\mathbb{Z} = [0, \infty)$ is a set of values of all possible GAAP deviations discovered in the audited reports, and $X = [0, \infty)$ is a set of all possible audit care levels. Then, $F(z|x) = \int_0^z f(t|x)\,dt$ will represent the probability of post-audit discovery of GAAP deviation up to size $z$, given that an audit care level $x$ was exercised. Assume that $F(x|z) = \frac{\partial F(z|x)}{\partial x} > 0$ and $F(x|z) = \frac{\partial^2 F(z|x)}{\partial x^2} < 0$. That is: (i) other things being equal, an auditor's higher level of care will reduce the probability of a GAAP deviation greater than $z$ being discovered after the audit (because larger GAAP deviations are more likely to have been detected in the manager's report during the audit); and (ii) there are diminishing marginal returns to efforts of auditors detecting a GAAP deviation.

A materiality threshold of GAAP deviation which is well agreed upon in the audit profession is assumed to exist. This assumption is made in order to simplify the model given that materiality \textit{per se} is beyond the scope of the study. Let $\bar{z}$, $\bar{z} \in \mathbb{Z}$, denote the materiality threshold so that $F(\bar{z}|x)$ denote the probability of material GAAP deviation being discovered ex post. Assume that, for $z > \bar{z}$, $f(x|z) = \frac{\partial f(z|x)}{\partial x} < 0$ and $f(x|z) = \frac{\partial^2 f(z|x)}{\partial z} < 0$. This captures the idea
that for a relatively large $z$, a higher audit care reduces the probability of a GAAP deviation whose size is in the neighborhood of $z$, and that a larger $z$ is less likely to remain after an audit was performed with a given level of audit care.

Let $X_s$, $X_s \in X$, denote the due care standard determined by the generally accepted auditing standards (GAAS). Practically, GAAS is interpreted by the Auditing Standards Board (ASB) through Statements on Auditing Standards (SAS) with quasi-legal stature. Kinney (1983) states,

GAAS define a 'standard quality' audit. In turn, the standard quality audit is a concept used by the legal system as the basis for determining whether an auditor has conducted a sufficient audit under the common law or the securities acts. Thus, the ASB's activities lead to pronouncements with quasi-legal stature. (p. 3.)

If an auditor uses a care level of at least $X_s$, $X_s \in X$, he is non-negligent, and his audit is standard or above-standard. If an auditor uses a care level of $X_n$, $X_n \in \{x: x \in X \& x < X_s\}$, he is negligent, and his audit, substandard. Thus, $f(z|X_s)$ (or $f(z|X_n)$) represents the conditional probability of $z$ being discovered ex post given that an audit was standard (or substandard).

If the audited statements are found to deviate materially from GAAP and the related audit service is found to be of substandard quality, the auditor who performed the audit will be liable for the owner's damages due to GAAP deviation. The owner can collect the damages if he sues and wins the lawsuit. The legal system where the negligence rule is in effect is assumed to work perfectly.
auditor will lose a lawsuit brought against him if and only if the report's deviation from GAAP is material and he does not exercise due care.

2. Individual Decision Behaviors

2.1. The Owner

The owner of each firm in the market is assumed to maximize his own expected utility. He will be either risk-neutral or risk-averse with regard to his wealth, M: $U_1' = \partial U_1(M)/\partial M > 0$, $U_1'' = \partial^2 U_1(M)/\partial M^2 = 0$, $U_2' = \partial U_2(M)/\partial M > 0$ and $U_2'' = \partial^2 U_2(M)/\partial M^2 < 0$ where $U_1(M)$ and $U_2(M)$ denote the utility functions of the risk-neutral and risk-averse owners, respectively. Further assume that all the risk-averse owners have the same concave utility function. The proportion of risk-averse owners in the market, which is denoted by $r$, is assumed to be known to all the market participants. But the auditors are assumed to have no way to know which particular type of owner they have.

When an audited report is found to materially deviate from GAAP, the owner may realize that his economic decisions such as investment decisions have been misled by the report. If he sustains some economic loss due to this, he might bring a lawsuit against the auditor of the erroneous report.

Let $w$ be the wealth of the owner if he has no loss due to GAAP deviation. If he sustains loss due to GAAP deviation, $l$, and does not litigate, his wealth will be $w - l$. If he litigates, he will incur
litigation costs: some irrecoverable costs, $k_1$, and the remainder, $k_2$, recoverable in case of winning. Therefore, his wealth will be $w - k_1$ in case of winning or $w - l - k_1 - k_2$ in case of losing. Assume that $l$ is greater than $k_1$ since no litigation would occur otherwise.

If the owner sustains loss, his decision problem is whether or not to sue the auditor. The first step will be to find some signal for his decision making. This signal will be the size of the GAAP deviation, $z$, $z \in \mathbb{Z}$. The observation of the signal is costless because a GAAP deviation is discovered as a random event as was assumed before. The signal in fact is used as the owner's measure of audit quality though it is imperfect because it does not perfectly reveal whether or not the audit was performed with due care.

The owner's next step will be to find the best critical value, $z^*$, for deciding whether to litigate or not so that he may litigate if observed value of $z$ is greater than $z^*$. Because he loses a lawsuit if $z$ is not material, $z^*$ must be greater than $\overline{z}$, the materiality threshold. Then, $F(z^*|X_s)$ represents the probability that an auditor will not be sued given that he exerted the standard level of audit care. (Recall that $F(z|x)$ represents the probability that GAAP deviation up to size $z$ is discovered ex post, given $x$.) Similarly, $F(z^*|X_n)$ is the probability that an auditor will not be sued, given any $X_n$, a substandard level of audit care used.

The owner's decision problem to select a critical value, $z^*$, which maximizes his expected utility will be represented by:
Max \( (1-e)\cdot [F(z|X_s)\cdot U_i(w-\ell) + (1- F(z|X_s))\cdot U_i(w-\ell-k_1-k_2)] + \)
\[ \sum_{e Z} e\cdot [F(z|X_n)\cdot U_i(w-k_1) + (1- F(z|X_n))\cdot U_i(w-k_1)] \quad \ldots \quad (3.1) \]

where \( i \): type of owner, risk-neutral \((i=1)\) or risk-averse \((i=2)\),
\( e \): proportion of substandard audits, which forms the owner's prior probability of receiving a substandard audit,
\( w \): owner's wealth in the absence of GAAP deviation loss,
\( \ell \): owner's loss due to GAAP deviation,
\( k_1 \): owner's litigation costs recoverable in case of winning a lawsuit,
\( k_2 \): owner's litigation costs irrecoverable even in case of winning a lawsuit.

The first term of equation (3.1) represents the owner's expected utility in the case of a potentially unsuccessful lawsuit; and the second term, the owner's expected utility in the case of a potentially successful lawsuit.

The first order condition for objective function (3.1) will be:

\[
[(1-e)\cdot f(z_1|X_s)+e\cdot f(z_1|X_n)]\cdot U_i(w-\ell) = e\cdot f(z_1|X_n)\cdot U_i(w-k_1)
\]
\[ + (1-e)\cdot f(z_1|X_s)\cdot U_i(w-\ell-k_1-k_2), \quad i = 1, 2, \ldots \ldots \ldots \quad (3.1.a) \]

where \( z_1 \) represents owner \( i \)'s \( z^* \).

The left-hand side of equation (3.1.a) represents the owner's expected marginal loss due to his lawsuit; and the right-hand side represents his expected marginal gain from the lawsuit.
Define \( R(z|X_n,X_s) = \frac{f(z|X_n)}{f(z|X_s)} \) where \( X_n < X_s \). Then it follows, for \( z > \bar{z} \), \( R_s = \frac{\partial R(z|\ldots)}{\partial X_s} > 0 \) and \( R_n = \frac{\partial R(z|\ldots)}{\partial X_n} < 0 \) due to \( f(x|z) < 0 \). This means, ceteris paribus, (i) a GAAP deviation in the neighborhood of \( z (z > \bar{z}) \) is more likely to come from a substandard audit as the due care standard increases and (ii) such a GAAP deviation is less likely to come from a substandard audit as the substandard level of care selected by an auditor increases. Therefore, \( R(z|\ldots) \) can be interpreted as a likelihood ratio depending on \( z \) given \( X_s \) and \( X_n \).

Assume \( R(z|\ldots) \) is an increasing function of \( z \): \( R_z = \frac{\partial R}{\partial z} = \frac{[f(z|X_n) \cdot f(z|X_s) - f(z|X_s) \cdot f(z|X_n)]}{[f(z|X_s)]^2} > 0 \); a higher value of \( z \) will signal a higher probability of an audit's being completed without due care. This assumption follows from the presumption that the greater the size of GAAP deviation discovered ex post, the more likely it comes from a substandard audit.

Rearranging the first order condition, (3.1.a), yields:

\[
\frac{e \ f(z_i|X_n)}{1-e \ f(z_i|X_s)} = \frac{e \ R(z_i|X_n,X_s)}{1-e} = \lambda_i \quad \ldots \ldots (3.1.b)
\]

where \( \lambda_i \) defines \( \frac{U_{i_1}(w-k_1-k_2)}{U_{i_1}(w-k_1)} = \frac{U_{i_1}(w-k_1-k_2)}{U_{i_1}(w-k_1)}, \quad i = 1, 2. \)

Therefore,

\[
e = \lambda_i/(\lambda_i + R(z_i|X_n,X_s)) \quad \ldots \ldots \ldots (3.1.c)
\]
Rearranging this equation yields the first equilibrium condition:

\[ \lambda R(z_1|X_n,X_s) = R(z_2|X_n,X_s) \text{ where } \lambda = \frac{\lambda_2}{\lambda_1}. \quad (I) \]

This equilibrium condition yields the following interesting lemma.

**[Lemma 3.1]** \( \lambda > 1, \text{ and } z_2 > z_1 \) where \( 0 < \epsilon < 1 \).

Proof: In equation (3.1.b), \( \lambda_2 \) is greater than \( \lambda_1 \) by Pratt’s theorem (1964) since \( U(w-k_1) > U(w-\lambda) > U(w-\lambda-k_1-k_2) \). Thus \( \lambda \) is greater than 1. Therefore, \( R(z_2|\ldots) \) must be greater than \( R(z_1|\ldots) \). Thus, \( z_2 > z_1 \) since \( R_z = \frac{\partial R(z|\ldots)}{\partial z} > 0 \). Q.E.D.

This lemma implies that, given the same loss due to GAAP deviation and the same legal costs, a risk-averse owner will bring a lawsuit against an auditor less frequently than a risk-neutral owner.

**2.2. The Auditor**

The audit is performed by a large number of auditors exhibiting constant cost, \( C \), (including normal profit) per unit of audit care. Audit care (for example, audit hours) is quantified by \( X \), \( X \in \mathbb{R}^+ \). Therefore, the cost (including normal profit) of using care level, \( X \), is \( C \cdot X \). It represents the value of human and physical resources consumed in exercising the \( X \) level of audit care. The audit fee will be determined based on the standard level of care, \( X_s \). Because all audits
appear homogeneous in the market, and the price of an audit in the competitive market is set equal to the cost of the standard care, all auditors will receive the audit fee being equal to $C \cdot X_s$ for an audit. All auditors need not perform the same quality audit where the audit quality is defined as the level of care, $X$, used by the auditor.

Since auditors do not examine justification for every dollar in the financial reports and since they may draw incorrect inferences from what they examine, there exists some risk that auditors will unknowingly draw wrong conclusions. This risk is unlikely to be eliminated but can be reduced by doing sufficient work (SAS No. 47). This implies that a higher level of audit care increases the probability that GAAP deviation is detected during the auditing, and decreases the probability that it is discovered after the audit's completion. This is consistent with the previous assumption that $G_x(z|x) = \partial G(z|x)/\partial x > 0$ and $F_x(z|x) = \partial F(z|x)/\partial x > 0$.

If an auditor uses a care level of at least $X_s$, the standard care, he will not be liable for any GAAP deviation which may be found after the audit. If an auditor uses a care level of less than $X_s$, he will be liable for any material GAAP deviation if the owner sues (because the auditor will lose the suit where the court works perfectly as is assumed), and he will pay the owner the loss due to the GAAP deviation (owner's award) plus legal costs. The auditor is assumed to have an expectation of these costs, denoted as $B$, which is affected by his care level and other factors. These other factors will be technically
collapsed into a shifting parameter, \( \theta \). Thus, \( B = B(x, \theta) \), and assume \( B_x = \partial B/\partial x < 0 \) and, without loss of generality, \( B_\theta = \partial B/\partial \theta > 0 \).

The auditor will select the level of care which maximizes his expected profit, given that 1) if he exerted an \( X_n \), he will be held liable whenever he is sued; 2) if he exerted \( X_s \), he will be never held liable; and that 3) each group of owners have selected the critical values to make a decision about whether to litigate. Let \( S \) denote the probability that an auditor will be sued, given he used \( x \) while auditing. This probability is a weighted average of \( [1 - F(z_1|x)] \):

\[
S = S(r, z^*|x) = (1-r) \cdot [1-F(z_1|x)] + r \cdot [1-F(z_2|x)]. \tag{3.2}
\]

The auditor's expected profit maximization problem is equivalent to the expected cost minimization problem because every auditor receives the same audit fee in the market for quality-indistinguishable audits. The expected total cost of an auditor, \( Y \), is the costs of care level (avoidance costs) plus the expected costs of litigation:

\[
Y = C \cdot X + B \cdot S \tag{3.3}
\]

More specifically,

\[
Y = Y_s = C \cdot X \text{ if } X \geq X_s \text{ because no } B \text{ is paid.} \tag{3.3.a}
\]

\[
Y = Y_n = C \cdot X_n + B \cdot S \text{ if } X = X_n < X_s. \tag{3.3.b}
\]
The decision problem of the auditor is represented by:

\[
\text{Min} \ [Y_{s*}, Y_{n*}] \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad (3.4)
\]

\[
X \in X
\]

where \( Y_{s*} = \text{Min}_{X \in \{x: x \in X \text{ and } x \geq X_s\}} Y_s = C \cdot X, \)

\[
Y_{n*} = \text{Min}_{X \in \{x: x \in X \text{ and } x < X_s\}} Y_n = C \cdot X_n + B \cdot S.
\]

This cost minimization yields the second equilibrium condition:

\[
X_s = \text{argmin} \ Y_s,
\]

\[
X_{n*} = \text{argmin} \ Y_n \text{ such that } C+B \cdot S+B \cdot S \cdot x = 0 \text{ where } S_x = \frac{\partial S}{\partial x}. \quad \quad \quad (\text{II})
\]

3. Propositions

This section provides and proves eleven propositions.

**Proposition 3.1:** An auditor is less likely to be sued, 1) as the proportion of owners who are risk-averse increases; 2) as owners choose higher critical values; and 3) as the auditor's care level is increased.

Proof: Taking the partial derivatives of equation (3.2) yields:

1) \( S_r = \frac{\partial S}{\partial r} < 0; \)

2) \( S_z_1 = \frac{\partial S}{\partial z_1} < 0 \) and \( S_z_2 = \frac{\partial S}{\partial z_2} < 0; \) and
3) \( S_x = \frac{\partial S}{\partial x} < 0 \). Q.E.D.

For further analysis, note here the signs of \( \frac{\partial^2 S}{\partial x^2}, \frac{\partial^2 S}{\partial x \partial r}, \) and \( \frac{\partial^2 S}{\partial x \partial z}: S_{xx} > 0, S_{xr} > 0, \) and \( S_{xz}^* > 0 \).

If all loss due to discovered material GAAP deviation (the auditor's expectation of which, \( B \), exists) is internalized, that is, the auditor is willing to pay such loss and thus the expected loss is fully reflected in the auditor's cost function, the expected total costs, \( Y_0 \), for the auditor employing an \( X \) level of care will be:

\[
Y_0 = C \cdot X + B(X, \Theta) \cdot \{1 - F(\bar{Z} | X = X)\}.
\]

Let \( X_0^* \) be a particular \( X \) minimizing \( Y_0 \). Then,

\[
\begin{align*}
X_0^* &= \text{argmin } Y_0 \text{ such that } C - B(X_0^*, \Theta) \cdot F_x(\bar{Z} | X = X_0^*) = 0, \quad \text{(3.6)} \\
Y_0^* &= C \cdot X_0^* + B(X_0^*, \Theta) \cdot \{1 - F(\bar{Z} | X = X_0^*)\}. \quad \text{(3.7)}
\end{align*}
\]

Here, \( Y_0^* \) becomes the total costs which an auditor would expect with his optimized care level, \( X_0^* \), if, whenever a material GAAP deviation is found ex post, he is willing to pay all loss due to it regardless of how much care he uses. No litigation would occur in this case.

**Proposition 3.2:** \( Y_0^* \) is greater than or equal to \( Y_n^* \). This means that when a due care standard and the negligence liability system
are in effect, the total costs which an auditor would expect to bear if
he is willing to pay all loss due to material GAAP deviation found ex
post is, ceteris paribus, not less than those which a negligent auditor
expects to bear.

Proof: See Appendix B.

Proposition 3.3: The optimal level of care, $X_0^*$, which minimizes
the expected costs that fully internalize the owner's loss due to
material GAAP deviation, is not necessarily greater than the optimal
level of negligence, $X_n^*$, which minimizes the expected costs that do
not fully internalize the owner's loss.

Proof: See Appendix B.

The last two propositions have an important policy implication
with respect to the form of the auditor's legal liability system. If
an auditor were to be liable for any material GAAP deviation regardless
of the degree of his audit care, his expected total audit cost would
not be smaller than that of a negligent auditor in the presence of a
due care standard (Proposition 3.2). However, the optimized care level
of the former is not necessarily greater than that of the latter
(Proposition 3.3). Therefore, an attempt to change auditor's legal
liability system from the negligence system toward the (semi-) strict
liability one in an anticipation of improving audit quality might
simply impose higher cost on the auditors without any guarantee that audit quality is improved.  

Proposition 3.4: \( Y_s^* \geq Y_n^* \) in equilibrium.  

Proof: Suppose \( Y_s^* \) is smaller than \( Y_n^* \) in equation (3.4). Then, all auditors will select \( X_s \) (where they face the same cost of care and owners cannot obtain perfect information concerning the audit quality). The owners who know the auditor's cost function will recognize that the choice of \( X_s \) is prevalent for all auditors and will not litigate no matter what loss due to GAAP deviation he sustains because he knows he will lose the litigation. This implies that \( z^* \) goes to infinity so that \( S = 0 \), which results in \( X_n^* = 0 \) and \( Y_n^* = 0 < Y_s^* \) by equation (3.4). This contradicts to \( Y_s^* < Y_n^* \). Therefore, \( Y_s^* < Y_n^* \) can not be an equilibrium phenomenon. Q.E.D.

Proposition 3.5: A necessary condition for a due care standard to be effective is that it should not be above \( X_u \) where \( X_u = Y_0^*/C \), or equivalently \( Y_0^* \geq Y_s^* \). This means that the upper limit of an effective \( X_s \) is \( X_u \): if a due care standard, \( X_s \), is set above the upper limit, the standard will not be effective in the sense that there will be a corner solution, where no auditor will conform to such a high standard (Simon's Uniform Equilibrium). In this case, all owners sustaining material GAAP deviation will litigate, and the care level employed by the auditors will be \( X_0^* \), as given by equation (3.6).
Proposition 3.6: When a due care standard is effective, \( Y_{s*} \) must be equal to \( Y_{n*} \) in equilibrium.

Proof: We know that \( Y_{s*} \leq Y_{n*} \) in equilibrium by Proposition 3.4. Now suppose \( Y_{s*} \) is strictly greater than \( Y_{n*} \). Then, all auditors will select \( X_{n*} \) (lower than \( X_{s} \)), and the owner who knows the auditor's cost function will litigate whenever he sustains loss due to material GAAP deviation. This implies \( Y_{n*} = C \cdot X_{n*} + B(X_{n*}, \theta) \cdot S(r, z | X_{n*}) \), which is exactly equal to \( Y_{o*} \). Together with the effectiveness of the due care standard implying \( Y_{s*} \leq Y_{o*} \) (by Proposition 3.5), it follows \( Y_{s*} \leq Y_{n*} \). This contradicts the initial supposition of \( Y_{s*} > Y_{n*} \). Therefore, \( Y_{s*} = Y_{n*} \). Q.E.D.

This proposition yields the third equilibrium condition when the due care standard is effective: the expected total cost must be equal for every auditor in equilibrium.

\[ Y_{s*} = Y_{n*}, \text{ i.e., } C \cdot X_{s} = C \cdot X_{n*} + B \cdot S. \] \hspace{1cm} (III)

Proposition 3.7: If a due care standard is effective: \( X_{s} < X_{u} \), some fraction, \( e, 0 < e < 1 \), of total audits will be substandard (Simon's Mixed Equilibria).

Proof: See Appendix B.
Propositions 3.5 and 3.7 can be clearly demonstrated in Figure 1 (see Appendix D for Figures). The expected total audit cost, $C \cdot X + B(X, \theta) \cdot \{1 - F(\bar{Z}|X)\}$, is graphed as a function of the auditor's care level, $X$, in a hypothetical situation where all the owners sustaining material GAAP deviation litigate. The curve, $C \cdot X + B(X, \theta) \cdot S(r, z*|X)$, depicts an auditor's expected total cost when some of the owners sustaining material GAAP deviations do not litigate. When an auditor chooses a substandard care level, $X < X_s$, he will be liable if he is sued. When he chooses a above-standard care level, $X \geq X_s$, he will not be liable. The expected total audit cost is just cost of care level (avoidance cost) if $X$ is above a due care standard ($X_{s1}$ or $X_{s2}$ in the figure), and it equals the avoidance cost plus the expected litigation cost if $X$ is below the standard.

If a due care standard is greater than $X_u$, the kinked cost curve, $C \cdot X + B(X, \theta) \cdot \{1 - F(\bar{Z}|X)\}$, has a minimum of $Y_o*$ at $X=X_o^*$, and if some owners do not litigate, the kinked curve, $C \cdot X + B(X, \theta) \cdot S(r, z^*|X)$, is minimized at even below $Y_o*$. Clearly all auditors will become negligent by choosing $X_o^* < X_s$, if the standard ($X_{s1}$) is set higher than $X_u$.

If a standard ($X_{s2}$) is lower than $X_u$, the minimum expected total cost of a negligent auditor with a care level of $X_n*$ is, in equilibrium, equal to the avoidance cost of a non-negligent auditor with the due care, $X_{s2}$. The level of $S$ determined in $C \cdot X + B \cdot S$ will be an equilibrium level of litigation probability given the due care standard, $X_{s2}$. 
Consider how the exogenous variables such as $X_s$, $C$, $r$, and $\theta$ will affect the endogenous variables such as $z_1$, $z_2$, and $X_n^*$. 

Recall the three equilibrium conditions:

\begin{align*}
\lambda \cdot R(z_1|X_n,X_s) &= R(z_2|X_n,X_s), \quad \lambda = \lambda_2/\lambda_1 > 1. \quad \text{............ (I)} \\
C + Bx(X_n^*,\theta) \cdot S(r,z^*|X_n^*) + B(X_n^*,\theta) \cdot Sx(r,z^*|X_n^*) &= 0. \quad .... (II) \\
C \cdot X_n^* + B(X_n^*,\theta) \cdot S(r,z^*|X_n^*) &= C \cdot X_s. \quad \text{................. (III)}
\end{align*}

Full differentiation of (I), (II) and (III) with respect to all the endogenous and exogenous variables yields the following equation system.

\[
\begin{bmatrix}
\lambda \cdot R_z1 & -R_z2 & \lambda \cdot R_{1n} - R_{2n} \\
B \cdot Sx_z1 & B \cdot Sx_z2 & Bx \cdot Sx + B \cdot Sx \\
B \cdot Sz_1 & B \cdot Sz_2 & C + Bx \cdot S + B \cdot Sx
\end{bmatrix}
\begin{bmatrix}
dz_1 \\
dz_2 \\
dXn^*
\end{bmatrix}
= 
\begin{bmatrix}
-\lambda \cdot R_1S + R_2S & 0 & 0 \\
0 & -1 & -B \cdot Sx_r - B_\theta \cdot Sx \\
C & X_s - X_n^* & -B \cdot Sr - B_\theta \cdot S
\end{bmatrix}
\begin{bmatrix}
dXs \\
dC \\
dr \\
d\theta
\end{bmatrix}
\]

where $R_z1 = \partial R(z_1|..)/\partial z_1$, $R_z2 = \partial R(z_2|..)/\partial z_2$, $R_{1n} = \partial R(z_1|..)/\partial X_n$, $R_{2n} = \partial R(z_2|..)/\partial X_n$, $R_1S = \partial R(z_1|..)/\partial Xs$, $R_2S = \partial R(z_2|..)/\partial Xs$.

Let $D$ denote the determinant of the $3 \times 3$ matrix of the left-hand side of the above equation system. Then,

\[
D = -(Bx \cdot Sx + B \cdot Sxx) \cdot (\lambda \cdot R_z1 \cdot Sz_2 + R_z2 \cdot Sz_2) > 0.
\]
**Proposition 3.8**: When the effective due care standard is raised,
1) the owners will be more likely to litigate as a result of their
lowered litigation critical values \((z_1, z_2)\); and 2) the optimized
substandard care level, \(Xn^*\), will increase.

**Proof**: A comparative static analysis using equation system (3.9)
yields:

1) \(dZ_j/dXs = -C \cdot \lambda \cdot R_j \cdot n \cdot (Bx \cdot Sx + B \cdot Sxx)/D < 0\),
2) \(dZ_j/dXs = -C \cdot R_2 \cdot n \cdot (Bx \cdot Sx + B \cdot Sxx)/D < 0\);
3) \(dXn^*/dXs = B \cdot C \cdot (\lambda \cdot Rz_1 \cdot Sxz + Rz_2 \cdot Sxz_1)/D > 0\).

Note \(Sxx, Rz_1, Sxz_1 > 0\) and \(Bx, Sx < 0\). Q.E.D.

An intuition behind this formal result is as follows. When the
due care standard is raised, this increases the likelihood of an audit
being substandard (note \(Rs = \partial R/\partial Xs > 0\)). This will pull down the
owner's litigation critical value, \(z^*\), which in turn increases \(S\), the
probability that a negligent auditor will be sued (No. 2 of Proposition
3.1). Then, the negligent auditor will have an incentive to increase
his care level toward the new standard level in an attempt to offset
such an unfavorable effect (No. 3 of Proposition 3.1). (This last
statement may appear contradictory to Proposition 3.3 if the strict
liability system is interpreted as a negligence rule with an unattainably
high due care standard. If this is the case, however, the due
care standard is not effective, and thus Proposition 3.8 does not hold
for the strict liability system. Therefore, the two propositions are not contradictory to each other.)

**Proposition 3.9:** Suppose that the due care standard is effective; and auditors continually adjust their care levels, $X$, and owners continually adjust their litigation criteria, $z_1$ and $z_2$, so that the first order conditions, (I) and (II), are satisfied. Then, if the proportion of audits which are substandard, $e$, is above the equilibrium level, negligent auditors will earn lower expected profits (i.e., incur higher expected total costs) than the non-negligent. Their profit maximizing desire will lead to a decrease in $e$, moving toward the equilibrium (Simon's Static Stability).

Proof: (Based on Simon [1981]) The probability that a negligent auditor will be sued, given a post-audit discovery of GAAP deviation, $S$, is given in equation (3.2). From condition (I), $dz_1/dz_2$ is positive. The right-hand side of equation (3.2) is a decreasing function of both critical values. Therefore, $S$ can be expressed as a function of $z_1$ alone, with $dS/dz_1 < 0$.

Differentiation of equation (3.1.c) with $i = 1$ with respect to $z_1$ and $e$ results in:

\[
\frac{dz_1}{de} = \frac{(\lambda_1 + R)^2}{\lambda_1 \cdot Rz_1} < 0. \quad \cdots \quad (3.10)
\]
This shows that, as more audits are performed in a negligent manner, an owner will choose a smaller critical value and sue more frequently. Therefore, if $e$ is above the equilibrium level, $e^*$, $S$ will be higher than the equilibrium level of $S$ for any $Xn^*$. Higher $S$ leads to higher expected total costs to negligent auditors (see equation [3.3.b]). Then the negligent auditors' expected profits will lie below the equilibrium level of profits. The condition (III) ensures that the expected profits of the negligent auditors must be equal to those of the non-negligent when the standard is effective. With $e > e^*$, negligent auditors will be expected to earn lower profits than those earned by the non-negligent. If this is the case, negligent auditors can increase their expected profits by becoming non-negligent. This results in a decrease in $e$, moving toward $e^*$. Similarly, if $e < e^*$, $e$ will increase since negligent auditors will be expected to earn more profits than non-negligent auditors. Q.E.D.

Proposition 3.10: When the due care standard is effective, as the cost of audit care increases, each type of owner will lower his litigation critical value so that litigation takes place more frequently. Also, the proportion of audits which are substandard, $e$, will increase, if the care level exercised by negligent auditors, $Xn^*$, does not go down.

Proof: When the cost of audit care goes up, the exceeding amount of a non-negligent auditor's total care cost over a negligent auditor's gets bigger. In the competitive market, the widened cost differential
must be shrunken back by the increased litigation cost of the negligent through the increased probability of his being sued. This will occur only when the owners lower their critical values since equation (III) implies that \((X_s - X_n)\frac{dC}{dC} = B \cdot S_{z_i} dz_i + (C + Bx \cdot S + B \cdot Sx) dXn^* = B \cdot S_{z_i} dz_i \) (note \(C + Bx \cdot S + B \cdot Sx = 0\) by equation (II)). Again, a comparative static analysis using equation system (3.9) produces:

\[
\frac{dz_1}{dC} < 0; \quad \frac{dz_2}{dC} < 0.
\]

From equation (3.1.c),

\[
de = -\left[\frac{\lambda}{(R_1 + \lambda_1)^2}\right] (R z_i dz_i + RndXn + Rsdxs). \quad \ldots \quad (3.11)
\]

Thus, \(e\) will go up if \(Xn^*\) does not go down. This will occur when \((S_{z_i} + (Xs - Xn^*) \cdot Sx z_i)\) is non-negative. (See Appendix B.) Q.E.D.

Proposition 3.10 shows that when the cost of audit work increases, auditors are litigated more frequently and, in a certain condition, more audits are likely to be substandard. Even though the condition, which is \(S_{z_i} + (Xs - Xn^*) \cdot Sx z_i \geq 0\), is hard to interpret, this condition seems to hold in reality because proposition 3.10 is considered quite may hold in reality because Proposition 3.10 is considered to describe contemporary phenomena quite well. It is interesting to note a recent public concern for audit quality where audit costs are increasing:

Even more frequently, auditors are failing to discover management frauds. A Congressional investigation has started and a barrage of multimillion-dollar lawsuits has come from Federal regulators, disgruntled shareholders and creditors of failed corporations. [T]he lawsuits do not indicate that the profession has suddenly become bankrupt in its ethics or dedication. Rather, the picture drawn is of a profession pressured by fierce
competition for owners to cut costs on audit examinations at a time when business transactions have become more complicated to trace and evaluate.  (The New York Times, May 13, 1984)

Proposition 3.11:  When the due care standard is effective, as the proportion of the owners who are risk-averse goes up, each type of owner will lower his litigation critical value.  Also, the proportion of audits which are substandard, e, will increase, if the care level exercised by negligent auditors, Xn*, does not go down.

Proof:  A comparative static analysis of equation system (3.9) shows:

\[ \frac{dz_1}{dr} < 0; \text{ and } \frac{de}{dr} > 0 \text{ if } Sz_1 \cdot Sxr - Sr \cdot Sxz_1 \geq 0 \text{ in which case } \frac{dXn*}{dr} \geq 0. \]  (See Appendix B.)  Q.E.D.

An intuition behind this formal result is as follows.  It was shown that, for a given effective due care standard, there exists an equilibrium level of litigation, S.  The equilibrium is initially disturbed by the increase in r, the proportion of the owners who are risk-averse.  Ceteris paribus, S will decrease by No. 1 of Proposition 3.1.  This effect must be offset by a lowered critical value, z*, so that S may move back upward to the equilibrium level (No. 2 of Proposition 3.1).
This section provides a numerical example prepared to facilitate the understanding of the model and the propositions in the previous sections.

Let the probability density function of \( z \), a GAAP deviation being discovered ex post, be \( f(z|x) = x \cdot \exp(-z \cdot x) \), where \( x > 0, z > 0 \). Then, its cumulative distribution is:

\[
F(z|x) = \int_0^z x \cdot \exp(-t \cdot x) \, dt = 1 - \exp(-z \cdot x).
\]

The properties of the functions satisfy the assumptions made in the model (for derivations, see Appendix E):

\[
\begin{align*}
fx &< 0 \text{ if } z \cdot x > 1, \\
F_x &> 0, \\
F_xx &< 0, \\
F_xz &< 0 \text{ if } z \cdot x > 1, \text{ and} \\
F_xz &> 0 \text{ if } z \cdot x > 1, \text{ and} \\
F_xz &> 0.
\end{align*}
\]

Let the utility functions of owners be \( U_1 = w \) for a risk-neutral and \( U_2 = \sqrt{w} \) for a risk-averse owner where \( w \) represents owner's wealth.

The three equilibrium conditions are expressed as follows.

From equilibrium condition (I):

\[
R(z_1|Xs,Xn) \cdot e/(1-e) = (Xn/Xs) \cdot \exp[z_1 \cdot (Xs-Xn)] \cdot e/(1-e) = \\
\{(w-k_1)^{1/n} - (w-l-k_2)^{1/n} \} + \{(w-k_1)^{1/n} - (w-l)^{1/n} \} \quad \ldots (1)
\]

where \( n = 1 \) if \( i = 1 \) and \( n = 2 > 1 \) if \( i = 2 \), and
\[ R(z_i | X_s, X_n) = X_n \cdot \exp(-z_i \cdot X_n)/(X_s \cdot \exp(-z_i \cdot X_s)) \]
\[ = (X_n/X_s) \cdot \exp[-z_i \cdot (X_n - X_s)]. \]

For the sake of notational convenience, define:

\[ A_1 = \log \left[ \frac{(k_1 + k_2)/(1-k_1)}{1} \right] \]
\[ A_2 = \log \left[ \frac{(w-\ell)^1/n - (w-\ell-k_1-k_2)^1/n}{1} + \left\{ (w-k_1)^1/n - (w-\ell)^1/n \right\} \right] \]

Therefore,

\[ e/(1-e) = \exp(A_1) + (X_n/X_s)\cdot\exp[z_i \cdot (X_s - X_n)] \text{ when } i = 1. \ldots (2) \]
\[ e/(1-e) = \exp(A_2) + (X_n/X_s)\cdot\exp[z_2 \cdot (X_s - X_n)] \text{ when } i = 2. \ldots (3) \]

Solve for \( e \) by equations (2) or (3):

\[ e = Q/(1+Q) \]

where \( Q = \exp(A_i)/(X_n/X_s)\cdot\exp[z_i \cdot (X_s - X_n)], \) \( i = 1, 2. \ldots \ldots (4) \)

From (2) and (3), derive:

\[ \exp(A_i)/(X_n/X_s)\cdot\exp[z_i \cdot (X_s - X_n)] = \exp(A_2)/(X_n/X_s)\cdot\exp[z_2 \cdot (X_s - X_n)] \]
\[ (z_1 - z_2) \cdot (X_s - X_n) - A_1 + A_2 = 0. \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (A) \]

Applying equilibrium condition (II), \( C + B \cdot S_n = 0; \)
\[ C - B \cdot \{(1-r) \cdot z_1 \cdot \exp(-z_1 \cdot X_n) + r \cdot z_2 \cdot \exp(-z_2 \cdot X_n)\} = 0, \quad r < 1. \]
\[ \{(1-r) \cdot z_1 \cdot \exp(-z_1 \cdot X_n) + r \cdot z_2 \cdot \exp(-z_2 \cdot X_n)\} - C/B = 0. \ldots (B) \]

Applying equilibrium condition (III), \( C \cdot X_s = C \cdot X_n + B \cdot S; \)
\[ C \cdot X_s = C \cdot X_n + B \cdot \{(1-r) \cdot \exp(-z_1 \cdot X_n) + r \cdot \exp(-z_2 \cdot X_n)\}, \quad r < 1. \]
\[ \{(1-r) \cdot \exp(-z_1 \cdot X_n) + r \cdot \exp(-z_2 \cdot X_n)\} - (X_s - X_n) \cdot C/B = 0. \ldots (C) \]
The numerical example will show how the solutions, $z_1$, $z_2$, and $Xn^*$ of the three simultaneous equilibrium conditions, (A), (B), and (C) will be affected by the changes of exogenous variables such as $X_s$, $C$, and $r$. Their effects on the equilibrium level of the proportion of the substandard audits, $e$, (determined by equation (4) above) will be also demonstrated. Other parameter values are set as follows:

$$w = 25,000,$$
$$l = 5,000,$$
$$k_1 = 500,$$
$$k_2 = 300,$$
$$B = 5,000.$$

The exogenous variables are varied as follows:

[Case 1] $X_s = 0.75 - 1.05$ while $r = 0.40$ and $C = 30.0$,

[Case 2] $C = 24.0 - 36.0$ while $r = 0.40$ and $X_s = 0.80$,

[Case 3] $r = 0.30 - 0.70$ while $X_s = 0.80$ and $C = 30.0$.

The results for Case 1 are presented in Table 1 and Graphs 1 - 3; for Case 2, in Table 2 and Graphs 4 - 6; and for Case 3, in Table 3 and Graphs 7 - 9 (see Appendix F for Tables and Graphs).

All the tables and graphs indicate that $z_2$ is greater than $z_1$ for any level of each of exogenous variables, $X_s$, $C$, and $r$. This is exactly what Lemma 3.1 dictates: given the same loss due to GAAP deviation and the same legal costs, a risk-averse owner will bring a law suit against an auditor less frequently than a risk-neutral owner because the former choose a higher critical value ($z_2$) than the latter ($z_1$).
Table 1 and Graphs 1 and 2 show that, as the due care standard is raised, both type of the owners lower their litigation critical values, \(z_1\) and \(z_2\), and the optimized substandard audit care level, \(Xn^*\), increases. This was expected by Proposition 3.8. Graph 3 indicates the proportion of the substandard audits at equilibrium, \(e\), goes up in this case.

Table 2 and Graphs 4 - 6 indicate that, as the cost of audit care increases, each type of owner will lower his litigation criterion value so that litigation takes place more frequently; and that the proportion of audits which are substandard at equilibrium, \(e\), increases even though the optimized substandard care level, \(Xn^*\), goes down. This is consistent with Proposition 3.10.

Table 3 and Graphs 7 - 9 show that as \(r\), the proportion of the owners who are risk-averse, goes up, each type of owner lowers his litigation criterion value; and that \(e\), the proportion of substandard audits at equilibrium, increases when the optimized substandard care level, \(Xn^*\), does not go down, as was predicted by Proposition 3.11. The case also shows that \(e\) keeps increasing even though \(Xn^*\) goes down.
PART IV

AUDIT QUALITY AND REPUTATION

Up to now, audit services have been assumed not to be distinguishable in the audit market. In other words, the owner of the firm was assumed not to have an auditor-specific measure of reliability about the audit service. This assumption seems to be very strong considering that over time the owner accumulates evidence about the differences between an auditor's reports and the subsequently revealed values of the owner's wealth (or investment), and constructs a certain measure of reliability of the audit service which directly relates to the auditor's professional reputation. This part will relax the previous assumption by considering the auditor's professional reputation and its effects.

1. Assumptions and Definitions

An auditor's professional reputation has various aspects. It may be related to his auditing skill or expertise, or perhaps to the cost efficiency of his auditing system, his ethical attitude, his management consulting ability, his capability to cover business operations over a
wide range of geography, and/or his level of audit care. Because the focus is the auditor's motivation to exercise due care in the presence of potential litigation, the analysis will be limited to the auditor's reputation for the level of care concerning his audit service.

Accommodating the reputation of an auditor will be operationally defined as public perception of the probability that he will perform an audit with due care according to the generally accepted auditing standards. Suppose that there are initially two reputation levels: one is a high reputation level, represented by \((1 - e_1)\) and the other is a low reputation level, \((1 - e_2)\), where \(e_1\) is smaller than \(e_2\).

Assuming that the audit market sets the price of an audit service fully reflecting the auditor's reputation, the high-reputed auditor will receive an audit fee of \((1-e_1) \cdot p \cdot X_s\) per unit of audit service requiring the standard level of care, \(X_s\), and the low-reputed auditor will receive an audit fee of \((1-e_2) \cdot p \cdot X_s\) per unit of audit service, where the notation, \(p\), represents a linear coefficient. This assumption is consistent with Darby and Karni (1973) who maintain that a firm which sells honest service will over time build up a reputation among its clients and that once the reputation is established, the firm can charge the higher prices consistent with its reputation. 36

Each type of auditor takes consequences of his audit service. If no material GAAP deviation of his audited reports is discovered ex
post, the auditor's reputation is strengthened and has a pecuniary benefit through an increase in his future audit fees whose present value is denoted $R_g$. If a material GAAP deviation of his audited reports is discovered ex post and the owner sues him for a loss due to the GAAP deviation, the auditor's reputation is harmed and will have a pecuniary loss through a decrease in his future audit fees whose present value is denoted $R_a$. If the law suit ends with the owner's winning, which implies that the litigated audit was substandard, the litigated auditor's economic loss is two-fold, the payment of the owner's award and the reputation loss resulting in a further decrease in present value of future audit fees, denoted $R_b$.

Furthermore, the notations and their definitions used in the previous part are carried over for use in this part. (See Appendix C.)

2. Individual Decision Behaviors

2.1. The Owner

The owner's decision environment in this part will be the same as in the previous part except that audit services are no longer assumed to be viewed as homogeneous by owners: instead, they are assumed to be distinguishable based on the kind of auditor.

Given that a material GAAP deviation is discovered ex post in the audited reports and that the owner sustains a loss due to the GAAP
deviation, \( l \), the owner's decision problem will be to select a litigation criterion value, \( z^* \), to maximize his expected utility. It is represented by:

\[
\text{Max } (1-e_j) \cdot [F(z_j|X_s) \cdot U(w-l) + (1-F(z_j|X_s)) \cdot U(w-l-k_1-k_2)] + e_j \cdot [F(z_j|X_n) \cdot U(w-l) + (1-F(z_j|X_n)) \cdot U(w-k_1)],
\]

where \( j = 1 \) for a high reputation and \( j = 2 \) for a low reputation auditor. .......................... (4.1)

The first order condition for objective function (4.1) will be the same as equation (3.1.a) except that both \( e \) and \( z \) are indexed to distinguish auditors. Rearranging the first order condition yields the following equilibrium condition:

\[
\frac{e_j \cdot f(z_j*|X_n)}{1-e_j \cdot f(z_j*|X_s)} = \frac{e_j}{1-e_j} \cdot \frac{R(z_j*|X_n, X_s)}{U(w-l) - U(w-l-k_1-k_2)} = \frac{U(w-l-k_1-k_2)}{U(w-k_1)} - \frac{U(w-l)}{U(w-k_1)}. \quad \text{.......................... (IV)}
\]

where \( R(z|\ldots) \) is as defined previously (see Appendix C).

The above equilibrium condition leads to the following lemma.

[Lemma 4.1] \( z_1^* > z_2^* \): An owner will choose a higher litigation criterion value for a high reputation auditor than for a low reputation auditor. Therefore, the former will be less frequently litigated than the latter, given that the owner sustains the same size of GAAP deviation loss.
Proof: Taking a differentiation of the last two terms of equilibrium condition (IV) with regard to \( z_j^* \) and \( e_j \) yields:

\[
{Rz_j^*e/(1-e_j)} \, dz_j^* + \{R/(1-e_j)^2\} \, de_j = 0, \quad j = 1, 2. \quad \ldots \ldots (4.2)
\]

Equation (4.2) implies \( dz_j^*/de_j = -R/Rz_j^*e_j^*(1-e_j) < 0 \) since \( 1-e_j \) and \( Rz_j = \partial R/\partial z_j^* \) are positive. This means a higher criterion value is chosen for a lower \( e \) (higher reputation), that is, \( z_1 > z_2 \) for \( e_1 < e_2 \). Because the probability of an auditor's being sued is \( 1 - F(z^*|x) \), which becomes lower as \( z^* \) becomes higher, a high reputation auditor (with \( e_1 \)) will be sued less frequently than a low reputation auditor (with \( e_2 \)), with other things being equal. Q.E.D.

2.2. The Auditor

The auditor with a high reputation and the auditor with a low reputation will have the following expected profit function:

\[
\Pi_j = \Pi_j,s \quad \text{if} \quad X \geq X_s, \quad \text{(i.e., with standard or higher audit care)}
\]

and

\[
\Pi_j = \Pi_j,n \quad \text{if} \quad X < X_s, \quad \text{(i.e., with substandard audit care)}
\]

where

\[
\Pi_j,s = \Pi_j,s(X) = (1-e_j) \cdot p \cdot X_s - C \cdot X - \{1-F(z_j^*|X)\} \cdot R_{a_j} + F(z_j^*|X) \cdot R_{g_j}, \quad \ldots (4.3)
\]

\[
\Pi_j,n = \Pi_j,n(X)
\]
\[(1-e_j^*\cdot p^*X_s - C^*X - (1-F(z_j^*|X))\cdot (B + R_{a_j} + R_{b_j})
+ F(z_j^*|X)\cdot R_{g_j}, \quad j = 1, 2. \] .......................... (4.4)

\[j = 1: \text{a high reputation auditor},\]
\[j = 2: \text{a low reputation auditor},\]

\[R_{a_j}: \text{auditor's loss of future engagements solely due to being litigated},\]
\[R_{b_j}: \text{auditor's loss of future engagements due to losing litigation},\]
\[R_{g_j}: \text{auditor's reputation gain due to absence of any litigation}.\]

The first term in the right-hand side (RHS) of each of equations (4.3) and (4.4) represents the auditor's audit fees depending on the audit work required by GAAS and the auditor's reputation. The next two terms of each equation represent the auditor's expected total cost: the second term represents the cost of care (avoidance cost); the third term of RHS of equation (4.3) represents the auditor's expected reputation loss due to just being litigated for an audit failure even though he exerted a sufficient level of audit care, and the third term of RHS of equation (4.4) represents the auditor's expected loss due to being litigated and losing the litigation because of his inadequate care, which equals the sum of the expected amount of the owner's award and the auditor's expected reputation loss. The last term of RHS of equation (4.3) represents the auditor's expected reputation gain due to avoiding litigation, and the last term of RHS of equation (4.4) represents the auditor's reputation gain due to avoiding litigation even though he exerted an inadequate level of audit care.
Equations (4.3) and (4.4) imply that, for each auditor, $\Pi$ is greater than $\Pi_n$ for every $X \in X$, because

$$\Pi_{j,s} - \Pi_{j,n} = (1-F(z_j^*|X)) \cdot (B + Rb_j) > 0.$$ 

The first order conditions to maximize functions (4.3) and (4.4) will be:

$$\frac{\partial \Pi_{j,s}}{\partial X} = -C + F_x(z_j^*|X) \cdot Ra_j + F_x(z_j^*|X) \cdot Rg_j = 0, \quad \ldots \quad (4.3.a)$$

$$\frac{\partial \Pi_{j,n}}{\partial X} = -C + F_x(z_j^*|X) \cdot (B + Ra_j + Rb_j) + F_x(z_j^*|X) \cdot Rg_j = 0,$$

respectively, $j = 1,2. \quad \ldots \quad (4.4.a)$

Let $X_{a.*}$ and $X_{b.*}$ be particular $X_j$'s satisfying equations (4.3.a) and (4.4.a), respectively. Then,

$$F_x(z_j^*|X=X_{a.*}) = C/(Ra_j + Rg_j), \quad \ldots \quad (4.5)$$

$$F_x(z_j^*|X=X_{b.*}) = C/(Ra_j + Rg_j + B + Rb_j), \quad j = 1,2. \quad \ldots \quad (4.6)$$

The two values, $X_{a.*}$ and $X_{b.*}$, are local maxima since the second order conditions are also satisfied because both $F_{xx} \cdot (Ra_j + Rg_j)$ and $F_{xx} \cdot (B + Ra_j + Rb_j)$ are negative. However, those are not necessarily the values of solution to the auditors' maximization problems because $X_{a.*}$ $\leq X_s$ and $X_{b.*} < X_s$ are not guaranteed. Figure 2 (also Figure 3) is presented in Appendix D for a better understanding of this.
[Lemma 4.2] $X_{a_j}^*$ is strictly less than $X_{b_j}^*$.

Proof: From equations (4.5) and (4.6), clearly $F_x(z_j^* | X = X_{a_j}^*)$ is greater than $F_x(z_j^* | X = X_{b_j}^*)$ because $C/(R_{a_j} + R_{g_j}) < C/(R_{a_j} + R_{g_j} + B + R_{b_j})$. Then, $X_{a_j}^*$ must be less than $X_{b_j}^*$ since $F_{xx} < 0$. Q.E.D.

[Lemma 4.3] The auditor will never choose a substandard level of care which is in a small neighborhood of $X_s$.

Proof: From equations (4.3) and (4.4), clearly
\[ \lim_{X \to X_s} \Pi_j(X) < \Pi_j(X = X_s). \] Note $F(\cdot, \cdot)$ is continuous. Q.E.D.

3. Propositions

This section provides propositions and their implications.

Proposition 4.1:

[1] An auditor will use a higher-than-standard level of audit care if and only if $F_x(z_j^* | X = X_s) > C/(R_{a_j} + R_{g_j})$ in which case his optimized care level is $X_{a_j}^* > X_s$.

[2] An auditor will use exactly the standard level of audit care if (1) $M_1 < F_x(z_j^* | X = X_s) < M_2$,

in which case $X_{a_j}^* < X_{b_j}^* < X_s$, and $\Pi_j(X_{b_j}^*) < \Pi_j(X_s)$,

where we define $M_1 = \{C \cdot (1 + X_s - X_{b_j}^*) - (B + R_{b_j})\}/(R_{a_j} + R_{g_j})$.
and \( M_2 = C/(R_{a_j}+R_{g_j}+B+R_{b_j}) \);

or (ii) \( M_2 \leq F_x(z_j^*|x=X_s) \leq C/(R_{a_j}+R_{g_j}) \) in which case \( X_{a_j}^* \leq X_s \leq X_{b_j}^* \).

(These conditions (i) and (ii) can be reduced to:
\[
\min \{ M_1, M_2 \} < F_x(z_j^*|x=X_s) \leq C/(R_{a_j}+R_{g_j}).
\]

[3] An auditor will use a substandard level of audit care
if \( F_x(z_j^*|x=X_s) < \min \{ M_1, M_2 \} \) where \( M_1 \) and \( M_2 \) are as defined above.

In this case, his optimized care level will be \( X_{b_j}^* < X_s \),
and \( \pi_{j,s}(X_{b_j}^*) > \pi_{j,s}(X_s) \).

Proof: The following five possible relationships between \( X_{a_j}^* \),
\( X_{b_j}^* \) and \( X_s \) can be established due to Lemma 4.2.

(1) \( X_s < X_{a_j}^* < X_{b_j}^* \).

(2) \( X_s = X_{a_j}^* < X_{b_j}^* \).

(3) \( X_{a_j}^* < X_s < X_{b_j}^* \).

(4) \( X_{a_j}^* < X_s = X_{b_j}^* \).

(5) \( X_{a_j}^* < X_{b_j}^* < X_s \).

In the case of (1), \( \pi_{j,n}(X<X_s) < \pi_{j,s}(X=X_s) < \pi_{j,s}(X=X_{a_j}^*) \) by Lemma 4.3 and the strictly increasing property of \( \pi_{j,n}(X) \), where \( X < X_s < X_{b_j}^* \). Therefore, \( X_{a_j}^* \) is chosen. This will occur when \( \partial \pi_{j,s}/\partial X \) is positive at \( X = X_s \), which is equivalent to \( F_x(z_j^*|x=X_s) > C/(R_{a_j}+R_{g_j}) \).
by equation (4.3.a). This proves part [1] of the proposition. Case A of Figure 3 in Appendix D helps in understanding this proof. This part of the proposition exhibits a simple economic phenomenon: as far as the marginal benefit of audit care is greater than the marginal cost, the auditor has an incentive to increase his audit care.

In the case of (2),

$$\Pi, s(X < X_s) < \Pi, s(X = X_s) > \Pi, s(X > X_s).$$

Thus, Xs (= Xa.*) is selected. In the cases of (3) and (4), Xs is also selected because

$$\Pi, n(X < X_s) < \lim_{X \to X_s} \Pi, n(X) < \Pi, s(X = X_s) > \Pi, s(X > X_s).$$

This will occur when $\partial \Pi, n / \partial X$ is negative and $\partial \Pi, n / \partial X$ is non-negative at $X = X_s$, which is equivalent to $C/(R_a + R_g + B + R_b)$ by equations (4.3.a) and (4.4.a). This proves (ii) of part [2]. Cases B and C of Figure 3 illustrate this proof.

Case (5) will occur when $\partial \Pi, n / \partial X$ at $X = X_s$ is negative, or equivalently, $Fx(z_j * | X = X_s) < C/(R_a + R_g + B + R_b) = M2$. Since $\Pi, s(X = X_s) > \Pi, s(X > X_s)$, and $\Pi, n(X = Xb_1 *) > \Pi, n(X < X_s, X \neq Xb_1 *)$, the maximized profit will be $\Pi, n^* = \max \{\Pi, s(X = Xs), \Pi, s(X = Xb_1 *)\}$. Therefore, Xs will be chosen if $\Pi, s(X = Xs) > \Pi, n(X = Xb_1 *)$. Otherwise $Xb_1 * (< X_s)$ will be chosen. The former case will occur when $Fx(z_j * | X = Xs)$ is greater than $\{C \cdot (1 + Xs - Xb_1 *) - (B + R_b)\}/(R_a + R_g) = M1$. Otherwise, the latter case will occur, i.e., $Fx(z_j * | X = Xs) \leq M1$. This proves (i)
of part [2], and part [3] of the proposition. This is exhibited by Case D of Figure 3 with the former case (selection of Xs) corresponding to \( \pi^1_{j,n} \) in the figure and the latter case (selection of Xb,*) corresponding to \( \pi^2_{j,n} \).

**Corollary 4.1:** An auditor will never exercise a higher-than-standard care level if \( C > (R_{aj} + R_{gj}) \).

**Proof:** \( Fx(\cdot, \cdot) \) is a probability function so its value never exceeds one (1). Therefore, the condition in Proposition 1-[1] never holds if \( C > (R_{aj} + R_{gj}) \). This can be also explained by noticing that \( \partial H_{j,s}/\partial x = -C + Fx(\cdot, \cdot) \cdot (R_{aj} + R_{gj}) \) is always negative if \( C > (R_{aj} + R_{gj}) \). No auditor will have any incentive to increase his care. Q.E.D.

**Proposition 4.2:** If the expected economic consequences of a potential litigation are the same for both kinds of auditors, i.e., \( R_{g1} = R_{g2}, R_{a1} = R_{a2}, \) and \( R_{b1} = R_{b2} \), a low-reputation auditor is less likely to perform a substandard audit than a high-reputation auditor.

**Proof:** Because \( z_2^* < z_1^* \), and \( Fx(z_2^*|x) > Fx(z_1^*|x) \) for every \( x \) due to \( Fxz^* < 0 \), a low-reputation auditor is more likely to satisfy the condition in Proposition 4.1-[1] than a high-reputation auditor. Moreover, a low-reputation auditor is more likely not to satisfy the condition in Proposition 4.1-[3]. Therefore, a low-reputation auditor is less likely to perform a substandard audit than a high-reputation auditor.
auditor. The proposition is consistent with intuition: Because, with other things being equal, a low-reputation auditor is subject to higher probability of being litigated than a high-reputation auditor (Lemma 4.1), the former will be more motivated to exert higher audit care to reduce the probability. Q.E.D.

Proposition 4.2 is only valid when the economic consequences of a potential litigation are expected to be the same for both kinds of auditors. When they are expected to be different, unambiguous conclusions about the auditor's behavior cannot be drawn. However, if a high-reputation auditor takes economic consequences of a potential litigation more seriously, the next proposition can be established.

Proposition 4.3: If the expected economic consequences of a potential litigation is (sufficiently) greater for a high-reputation auditor than for a low-reputation auditor, i.e., \( R_g_1 \gg R_g_2 \), \( R_a_1 \gg R_a_2 \), and \( R_b_1 \gg R_b_2 \), a high-reputation auditor is less likely to perform a substandard audit than a low-reputation auditor. (Read '\( \gg \)' as "sufficiently larger than").

Proof: Because \( (R_a_1+R_g_1) \gg (R_a_2+R_g_2) \), a high-reputation auditor is more likely to satisfy the condition in Proposition 4.1-[1] than a low-reputation auditor. Moreover, a high-reputation auditor is more likely not to satisfy the condition in Proposition 4.1-[3] because \( (R_a_1+R_g_1+B+R_b_1) \gg (R_a_2+R_g_2+B+R_b_2) \). Thus, a high-reputation auditor is less likely to perform a substandard audit than a low-reputation auditor. Q.E.D.
Proposition 4.4: When the due care standard is raised, the auditors are more likely to perform substandard audits, the owner will be more likely to litigate, and the optimized substandard care level, \( X_b^* \), will go up.

**Proof:** As the due care standard, \( X_s \), increases while other things remaining unchanged, \( F_x(z_j^*|X=X_s) \) becomes smaller since \( F_{xx} < 0 \). This results in the condition in Proposition 4.1-[1] being less likely to hold and the condition in Proposition 4.1-[3] being more likely to hold. Therefore, auditors are more likely to be negligent. Then, from equation (IV), owners will lower their critical values, \(^{39}\) which in turn raises \( X_b^* \), the optimized substandard care level due to equation (4.6). \(^{40}\) (cf. Proposition 3.8.) Q.E.D.

Proposition 4.4 suggests that there is an upper limit of the effective due care standard. When the due care standard, \( X_s \), goes up while other things remaining unchanged, \( F_x(z_j^*|X=X_s) \) becomes smaller while \( M_1 \) (in the condition in Proposition 4.1-[3]) becomes greater with \( M_2 \) unchanged. This implies that for some \( X_s \) beyond a certain high level, the condition in Proposition 4.1-[3] holds for every auditor so that no auditor has an incentive to exert a care level higher than the standard. This corresponds to the uniform equilibrium phenomenon in Proposition 3.5.

Proposition 4.5: As the cost of audit care increases, the auditors are more likely to perform substandard audits, the owner will
be more likely to litigate, and the optimized substandard care level, $X_{b^*}$, will go up.

Proof: As the audit cost, $C$, increases while other things remain unchanged, the condition in Proposition 4.1-[1] becomes less likely to hold and the condition in Proposition 4.1-[3] becomes more likely to hold due to an increase in both $M_1$ and $M_2$. The rest of the reasoning is similar to the one expressed in the proof of Proposition 4.4. (cf. Proposition 3.10.) Q.E.D.
PART V
SUMMARY AND CONCLUSIONS

1. Review and Summary of Results

Part 3 recognized the incentive problem of auditors in the absence (or inadequacy) of signals about the auditor's effort (level of audit care) upon which to base the (explicit) contract between the principal (owner) and the auditor. That part considered the existence of auditing standards and examined the institution of the auditors' legal liability as an (implicit) incentive scheme to reduce the moral hazard problem of the auditor. An economic model was developed under a set of assumptions where owners are not able to distinguish the quality of audits.

The model analytically showed the existence of the upper limit of the effective due care standard and a necessary condition for a due care standard to be effective (Props. 3.5 and 3.6). It demonstrated that the existence of the liability system with the effective due care standard alleviates the auditor's incentive problem even though it does not completely cure the problem. The cure is incomplete due to the imperfect and stochastic nature of signals about the auditor's care.
level: when the due care standard is effective, there exist both standard and substandard audits in the audit service market (Prop. 3.7). It further analyzed the effects that (i) risk preference of owners, (ii) the level of the due care standard and (iii) the audit costs have on the auditor's care level, the proportion of standard audits and the owner's litigation behavior (Props. 3.8 through 3.11). It has also shown that, in the market for indistinguishable audit services, no auditor is motivated to exercise audit care in excess of the due care standard, and discussed the two forms of legal liability system: strict and negligence liability systems.

Part 4 extended the model by incorporating the auditor's concern for his professional reputation. This extended model considers two types of auditors: high-reputation and low-reputation auditors, where reputation is defined as the market assessment of the probability that an auditor performs an audit with at least the standard care level. This model generates a set of conditions for an auditor to exercise a higher-than-standard care level, exactly the standard care level, or a substandard care level (Prop. 4.1). In particular, an auditor is motivated to exercise audit care in excess of the due care standard because he considers the effect of his present behavior on his reputation which has future economic consequences. Based on the above-mentioned conditions, it demonstrated how the two types of auditors would behave differently (Props. 4.2 and 4.3) and analyzed the impact of the due care standard and the audit costs on the likelihood of an
audit being substandard, the auditor's care level, and the owner's litigation behavior (Props. 4.4 and 4.5).

2. Limitations and Future Extensions

Throughout Parts 3 and 4, the implicit assumption was that the auditors have the same audit skill. The assumption appears strong but may not be. Auditors, in general, have been given relatively homogeneous high level education and have passed well-standardized professional examinations. When an auditor is viewed as 'an audit firm' as a whole (which the models implicitly considered), auditors may not be very different in auditing skill. Nonetheless, auditors are likely to be different in individual audit expertise and capability. Therefore, the relaxation of the same-skill assumption could produce results which describe actual auditing more adequately.

One of the findings in Part 3 is that both standard and substandard audits exist in equilibrium when the due care standard is effective and where audits are indistinguishable with regard to their quality (until a material error is discovered later in the audited report). However, this result can be said to be weak in the sense that it only declares the co-existence of the two types of audit as an equilibrium phenomenon, but is unable to explain which auditor will (or will be likely to) do what quality audit service because the model assumed identical production functions and cost conditions for all
auditors. If auditors are modeled to have different production functions and cost conditions, a stronger result may be obtained. This issue relates to the (aforementioned) relaxation of the same-skill assumption.

Part 4 used a single period approach in analyzing the reputation effects. But, reputation is evidently a multi-period phenomenon. Even though the model captures the reputation phenomenon by the use of some variables such as $e_j$, $R_{aj}$, and $R_{gj}$, a multi-period model is expected to give more complete analysis and stronger results.

Another limitation of the study is that it ignores the effect of the auditor's insurance, which is purchased to protect him from possible economic loss (and also to provide sufficient funds for the owner's award) when he loses a law-suit filed against him. The insurance problem could technically be avoided by the study because it modeled auditors as risk-neutral. However, if the auditor's professional insurance is included in the model by assuming auditors risk-averse, the analysis of the auditor's incentive problem would become more comprehensive and complete. The technical complexity associated with this analysis might make it impossible to obtain desired results, however.

Throughout the study, the due care standard was regarded as an exogenous variable. Therefore, the implications of the standard in the study should be interpreted in a limited manner. In order to extend the implications to a larger context such as the social welfare issue,
a broadened model which endogenously determines the social (or Pareto) optimum due care standard is required.
FOOTNOTES

1. See Antle (1981), DeJong (1983) and Nagarajan (1984), however. But none considers the audit service market and the auditor's professional reputation. The next part will discuss them with this regard.

2. Noel (1981) defines an information structure as a specification of what variables are observed, by whom they are observed, and when they are observed.

3. Stewardship demand arises when investors, for purposes of control, want to obtain information about the actions taken by managers to whom they delegate decision making.

4. See Baiman (1979) and Antle (1981) for this point.

5. Noel defines an information structure as a specification of what variables are observed, by whom they are observed, and when they are observed.

6. Akerlof says that the analogy is instructive but not quite complete: bad cars drive out the good because they sell at the same price as good cars since a buyer cannot tell the difference between a good and a bad car, which only the seller knows. Bad money drives out good because the exchange rate is even despite that both buyer and seller can tell the difference between good and bad money.

7. Various liability systems are summarized in Appendix A for interested readers.

8. See Appendix A for the negligence-contributory negligence rule.

9. See Appendix A for the negligence rule.

10. The condition established is that the court decision is 'informative' in the Holmstrom (1979) sense.


12. A first-best solution is achieved when full observation of agent actions is possible and an agent's contract that penalizes agent's dysfunctional behavior is enforced.


15. In the Ng and Stoeckenius model, a particular audit level is something discretionarily chosen by the owner, which may be true when an audit is performed for a special purpose. But the level of an audit in the general case of periodic auditing of financial reports is determined by the generally accepted auditing standards (GAAS) through the statements of auditing standards; it is not something designated by a particular person or group of people. The specific procedures required are matters for the auditor's judgement.

16. Minor modifications are made to the Ng and Stoeckenius model in order that the notation be consistent with the previous model.

17. Here, Ng & Stoeckenius (1979) assumed that there exists $\theta \in (0, \infty)$ such that (i) $\phi(D|k(w), \theta)$ is increasing and differentiable with respect to $k(w)$, and that its first derivative evaluated at $k(w)=0$ is nonzero, and (ii) $\phi(D|k(w), \theta) = 0$ when $k(w) \geq 0$.

18. The person who enters into a contract with an auditor appears to be the manager of a firm. But in many cases the selection of the auditor is under the control of the audit committee of the firm whose compensation is not directly affected by managerial decisions. This, together with the fact that the major beneficiary of and the ultimate fee payer for external auditing is the owner of the firm, leads to modeling the owner of the firm as the client of the auditor.

19. An auditor is expected to comply with professional ethics, sacrificing his own profits if he must. To assume an auditor is an economic agent does not deny that premise. It simply allows the focus to be on the effects of economic factors on the auditor's behavior and set aside the issue of ethics, which requires a different framework of analysis.

20. This assumption is not necessarily unrealistic. Bernstein (1978) observes increasing competition among auditing firms, and Dopuch and Simunic (1980) provide some indirect evidence to support an assumption of competitive behavior among large U.S. CPA firms. Based on these observations, Danos and Eichenseher (1982) assume that operating efficiencies of all CPA firms are equal.
21. The probability of post-audit discovery will also be affected by the efforts made by the subsequent auditor. However, who will do the subsequent audit and how well it will be done are not certain. Therefore, the probability of post-audit discovery will depend on the efforts exerted by the initial auditor and on random factors.

22. The manager of the firm will, of course, be liable too.

23. This assumption is made to simplify the model. If the assumption is relaxed, there may be cases in which the litigants settle out of court: when the court is imperfect and the litigants have different expectations about the court judgement, they may be better off settling out of court. (Also see Nagarajan [1984] for this point.)

24. The irrecoverable costs would include non-pecuniary (emotional) costs incurred by the litigants before and during the trial. Appropriate reimbursement for these costs cannot be calculated.

25. Theorem 1 of Pratt (1964) includes:

\[
\frac{U_1(y) - U_1(x)}{U_1(w) - U_1(v)} > \frac{U_2(y) - U_2(x)}{U_2(w) - U_2(v)}
\]

for all \(v, w, x, y\) with \(v < w \leq x < y\), iff \(r_1(.) < r_2(.)\), where \(r_i(.)\) represents the degree of (local) risk-aversion.

26. This \(B\) will be assumed to be a constant in the next part. The reason will be discussed when \(B\) is mentioned.

27. \(\arg\min Y(x) = x^*\) means that \(x^*\) is the argument minimizing \(Y(x)\). Thus, \(x^*\) satisfies \(Y^* = Y(x^*)\) where \(Y^* = \min_{x \in X} Y(x)\).

28. If a complete market is assumed, however, this proposition will become weaker. Risk-averse owners can sell to risk-neutral people -- for example, lawyers -- those litigation opportunities that increase the expected utility of the latter. Therefore, the likelihood or frequency of litigation may not be affected by the proportion of risk-averse owners.

29. See Appendix B.

30. See Appendix B.
31. The word "semi-" was used because the auditor is legally responsible not for all the GAAP deviations but only for material GAAP deviations. This liability rule may be called strict liability with materiality.

32. Note that uniform equilibrium with a high due-care standard will result in the same allocation of resources as a system of strict liability. The allocation would be optimal, if litigation were not costly, since loss due to GAAP deviation would be internalized, and the risk-neutral auditors would bear all the risks.

33. Here, note that (a), for the entries in the 3 by 3 matrix, \( \lambda \cdot Rnants = 0 \) because equation (I) holds for all \( Xn; C+B \cdot S+B \cdot Sx = 0 \) by equation (II); and (b) \( Bx, Sx \) and \( Sx \) are negative while \( Sx \) and \( Rx \) are positive.

34. From equilibrium condition (I), \( \lambda \cdot Rz, dz1 = Rz, dz2 \),
\[ \frac{dz2}{dz1} = \lambda \cdot Rz, / Rz < 0. \]

This result means that, in equilibrium, when the risk-neutral owners choose a higher critical value than before, so do the risk-averse clients.


36. Also, Shapiro (1983) derives an equilibrium price-quality schedule for markets in which buyers cannot observe product quality prior to purchase, and shows that the price-quality schedule involves high-quality items selling at a premium above their cost: this premium compensates sellers for their investment in reputation.

37. In this part, \( B \) will be regarded as a constant rather than a function of \( X \) as in the last part solely for the purpose of simplification of mathematical expression. The expected value of \( B \), which is important in the analysis rather than \( B \) per se, reflects its dependence on \( X \) through the probability function, \( F(X|X) \). This was confirmed when the use of constant \( B \) in the last part did not change the results at all.

38. From the relationship of \( \Pi _j,s > \Pi _j,n \) in equations (4.3) and (4.4),
\[ C \cdot (Xs-Xb) < (B+Rb) \cdot \{1-Fx(z^*|X=Xb)\} + \{Fx(z^*|X=Xs) - Fx(z^*|X=Xb)\} \cdot (Raj+Rgj), \]
or equivalently \( Fx(z^*|X=Xs) > \{C \cdot (1+Xs-Xb) - (B+Rb)\} / (Raj+Rgj) = M1 \) due to \( Fx(z^*|X=Xb) = C/(Raj+Rgj+B+Rb) = M2. \)
39. Take full differentiation of equation (IV) with regard to $z^*$, $X_n$ and $X_s$. Then, $R_z^* \, dz^* + R_n \, dX_n + R_s \, dX_s = 0$ when $R_z^*$, $R_s > 0$ and $R_n < 0$. This implies $z^*$ must go down when $X_s$ goes up.

40. Differentiation of equation (4.6) with regard to $z^*$ and $X_b^*$ results in $F_{xx}(z^*|X=X_b^*) \, dX_b^* + F_{xz}^*(z^*|X=X_b^*) \, dX_z^* = 0$ when $F_{xx} < 0$ and $F_{xz}^* < 0$. This implies $X_b^*$ will go up when $X_z^*$ goes down.
Brown (1973) puts into the following framework various liability rules that has been discussed in the previous literature.

Let \( X \) and \( Y \) be the accident avoidance controls which are controlled by Xavier the Injurer, and Yvonne the Victim, respectively. Let \( L_x(X,Y) \) and \( L_y(X,Y) \) be the liabilities of Xavier and Yvonne, respectively, such that \( L_x(X,Y) > 0 \), \( L_y(X,Y) > 0 \), and \( L_x(X,Y) + L_y(X,Y) = 1 \) for all \( X, Y \). Let \((X^*, Y^*)\) be the legal standard of negligence. Then, the liability rules are described as follows.

1. NO LIABILITY: The victim is liable under all circumstances.
   \[ L_x(X,Y) = 0, \quad L_y(X,Y) = 1 \quad \text{for all } X, Y. \]

2. STRICT LIABILITY: The injurer is liable under all circumstances.
   \[ L_x(X,Y) = 1, \quad L_y(X,Y) = 0 \quad \text{for all } X, Y. \]

3. THE NEGLIGENCE RULE: The victim is liable unless the injurer is found negligent.
   \[ L_x(X,Y) = 0, \quad L_y(X,Y) = 1 \quad \text{if } X \geq X^* \quad \text{and} \]
   \[ L_x(X,Y) = 1, \quad L_y(X,Y) = 0 \quad \text{if } X < X^*. \]

4. STRICT LIABILITY WITH CONTRIBUTORY NEGLIGENCE: The injurer is liable unless the victim is found negligent.
   \[ L_x(X,Y) = 1, \quad L_y(X,Y) = 0 \quad \text{if } Y \geq Y^* \quad \text{and} \]
   \[ L_x(X,Y) = 0, \quad L_y(X,Y) = 1 \quad \text{if } Y < Y^*. \]
5. THE NEGLIGENCE RULE WITH CONTRIBUTORY NEGLIGENCE: The injurer is liable if he is negligent and the victim is not. The victim is liable otherwise.
\[ \begin{align*}
L_x(x,y) &= 1, \quad L_y(x,y) = 0 \quad \text{if } x < x^* \text{ and } y > y^*, \\
L_x(x,y) &= 0, \quad L_y(x,y) = 1 \quad \text{otherwise.}
\end{align*} \]

6. STRICT LIABILITY WITH DUAL CONTRIBUTORY NEGLIGENCE: The victim is liable if he is negligent and the injurer is not. The injurer is liable otherwise.
\[ \begin{align*}
L_x(x,y) &= 0, \quad L_y(x,y) = 1 \quad \text{if } y < y^* \text{ and } x > x^*, \\
L_x(x,y) &= 1, \quad L_y(x,y) = 0 \quad \text{otherwise.}
\end{align*} \]

7. RELATIVE NEGLIGENCE: The injurer is liable if the increment to accident avoidance per dollar of avoidance by him is greater than that per dollar of avoidance by the victim, i.e., if a dollar spent by the injurer could have bought more avoidance than a dollar spent by the victim.
\[ \begin{align*}
L_x(x,y) &= 1 \quad \text{if } \frac{P_x(x,y)}{W_x} > \frac{P_y(x,y)}{W_y}, \quad \text{and } 0 \text{ otherwise;}
\end{align*} \]
where \[ \begin{align*}
P_x(x,y) &= \frac{dP(x,y)}{dx}, \\
P_y(x,y) &= \frac{dP(x,y)}{dy}.
\end{align*} \]
\[ P(x,y) = \text{Probability that an accident is avoided in a given time interval;} \]
\[ W_x, W_y = \text{Cost per unit of } X \text{ and } Y, \text{ respectively.} \]

8. COMPARATIVE NEGLIGENCE: The doctrine of comparative negligence apportions the liability according to the relative liability of the two parties. When a marginal concept is used, then, if \( N_x \) (or \( N_y \)) is the negligence of the injurer (or victim),
\[ \begin{align*}
N_x &= \frac{P_x(x,y)}{W_x} \quad \text{and } N_y = \frac{P_y(x,y)}{W_y}.
\end{align*} \]
Negligence is the incremental reduction in accident probability per dollar spent, and the liability of the injurer is his negligence divided by the negligence of both parties:
\[ \begin{align*}
L_x(x,y) &= \frac{N_x}{N_x + N_y}, \quad L_y(x,y) = 1 - L_x(x,y).
\end{align*} \]
APPENDIX B

FORMAL PROOFS OF PROPOSITIONS

Proposition 3.1

(i) \( S_r = \frac{\partial S}{\partial r} = F(z_1|x) - F(z_2|x) < 0 \) since \( z_1 < z_2 \). ... (3.2.a)
(ii) \( S_z_1 = \frac{\partial S}{\partial z_1} = -(1-r)*f(z_1|x) < 0, \) and
\( S_z_2 = \frac{\partial S}{\partial z_2} = -r*f(z_2|x) < 0. \) ................. (3.2.b)
(iii) \( S_x = \frac{\partial S}{\partial x} = -(1-r)*F_x(z_1|x) - r*F_x(z_2|x) < 0. \) .... (3.2.c)

Q.E.D.

For the use of further analysis, consider the signs of \( \frac{\partial^2 S}{\partial x^2} \), \( \frac{\partial^2 S}{\partial x \partial r} \), and \( \frac{\partial^2 S}{\partial x \partial z} \).

\( S_{xx} = \frac{\partial^2 S}{\partial x^2} = -(1-r)*F_{xx} - r*F_{xx} > 0 \) since \( F_{xx} < 0 \). ........ (3.2.d)
\( S_{xr} = \frac{\partial^2 S}{\partial x \partial r} = F_x(z_1|x) - F_x(z_2|x) > 0 \)
since \( z_1 < z_2 \), and \( F_{xz} = f_x(z|X) < 0. \) ........................................ (3.2.e)
\( S_{xz_1} = \frac{\partial^2 S}{\partial x \partial z_1} = \frac{\partial S_z}{\partial x} = -(1-r)*f_x(z_1|x) > 0, \) and
\( S_{xz_2} = \frac{\partial^2 S}{\partial x \partial z_2} = \frac{\partial S_z}{\partial x} = -r*f_x(z_2|x) > 0. \) ............... (3.2.f)

Proposition 3.2

\( y_0^* = \text{Min} \ Y_0 = \text{Min} \big\{C*X + B*\{1-F(z|x=X)\}\big\} \) and \( y_n^* = \text{Min} \ Y_n = \text{Min} \big\{C*X_n + B*S\big\}. \) Since \( \{1-F(z|x)\} \geq S \) for any given \( x \), \( y_0 \geq y_n \) for any given \( x \) (see equation \([3.3.b.]\)). It follows that \( y_0 \geq y_0^* \geq (y_n \text{ evaluated at } X_0^*) \geq y_n^* \).  

Q.E.D.

Proposition 3.3

From equations (II) and (3.2),
\( C + B*S_x = C - B*[(1-r)*F_x(z_1|X_0^*) + r*F_x(z_2|X_0^*)] = 0, \) or
\( -S_x = (1-r)*F_x(z_1|X_0^*) + r*F_x(z_2|X_0^*) = C/B, \) and,
from equation (3.6), \( F_x(Z|X_0^*) = C/B. \) Therefore, \( F_x(Z|X_0^*) = -S_x. \)
From \( \exists \{-Sx/\partial x < 0 \) due to \( Fxx(z|x) < 0 \) (see equation [3.2.d] above), the following results.

(i) \( X_0^* < X_n^* \) if \( Fx(\bar{z}|x) < -Sx \) for all \( x \). ...................... (3.8.a)

(ii) \( X_0^* > X_n^* \) if \( Fx(\bar{z}|x) > -Sx \) for all \( x \). ...................... (3.8.b)

(iii) \( X_0^* = X_n^* \) if \( Fx(\bar{z}|x) = -Sx \) for all \( x \). ...................... (3.8.c)

Q.E.D.

Proposition 3.5

(This proof bears on Simon [1981].)

If the cost of \( X_s \), \( Y_s^* \), is greater than \( Y_0^* \), the total cost of a standard audit exceeds the expected total cost of a substandard audit, \( Y_n^* \), for all levels of litigation possibility since \( Y_s^* > Y_0^* > Y_n^* = \text{Min} \{C \cdot X_n + B \cdot S\} \) by Proposition 3.2. All auditors will become negligent because a cost minimizing auditor has no incentive to exercise due care. This means any standard set above \( X_u \), where \( X_u = Y_0^*/C \), will not be effective. All owners sustaining loss due to material GAAP deviations will litigate since they are certainly aware of \( e = 1 \) and sure of winning all suits. That is, \( z^* = \bar{z} \). When this happens, \( S \) (in equation [3.3.b]) becomes \( 1-F(\bar{z}|X<XS) \), and \( Y_n \) becomes identical with \( Y_0 \). Thus \( X_n^* = \text{argmin} \ Y_n = \text{argmin} \ Y_0 = X_0^* \). \( Y_n^* = Y_0^* \), and \( X_n^* = X_0^* \). The result is equivalent to Simon's (1981) uniform equilibrium.

Q.E.D.

Proposition 3.7

(This proof also bears on Simon [1981].)

If owners are sure that all audits are substandard, i.e., \( e = 1 \), all the owners who sustain loss due to material post-audit GAAP deviations will litigate. So the expected total cost of every audit will be \( Y_0 = C \cdot X + B \cdot (1-F(\bar{z}|X)) \). Then, \( Y_0 \geq Y_0^* = C \cdot X_u > C \cdot X_s \). Because the cost of the standard audit is clearly lower than that of a substandard audit, no auditor will have an incentive to become negligent. Therefore, \( e = 1 \) can not be maintained.
On the other hand, if owners are sure that all audits are standard, i.e., \( e = 0 \), no litigation will occur. The cost of the standard audit \( (C \cdot X_s) \) will be substantially higher than the cost of a substandard audit because the latter would be \( Y_n = C \cdot X_n + B \cdot S = C \cdot X_n \) due to \( S = 0 \) and \( Y_n^* = C \cdot X_n^* = 0 \) due to \( X_n^* = 0 \). Therefore, an auditor will have a very high incentive to become negligent and \( e = 0 \) can not be maintained. Therefore, given that \( X_s \) is less than \( X_u \), there is an equilibrium level of \( e \), the proportion of audits which are conducted in a negligent manner such that \( 0 < e < 1 \). This is equivalent to Simon's mixed equilibrium. This, in turn, will determine the equilibrium level of litigation probability, \( S \), \( 0 < S = \{1-F(z^*|x=X_n^*)\} < \{1-F(z|x=X_0^*)\} \), and the equilibrium level of the substandard care, \( X_n^* \). Q.E.D.

**Proposition 3.10**

\[
\frac{dz_1}{dC} = -Rz_2 \cdot (X_s-X_n) \cdot (B_x \cdot S_x + B \cdot S_{xx}) / D < 0;
\]

\[
\frac{dz_2}{dC} = -\lambda \cdot Rz_1 \cdot (X_s-X_n) \cdot (B_x \cdot S_x + B \cdot S_{xx}) / D < 0;
\]

\[
\frac{dX_n^*}{dC} = B \cdot (\lambda \cdot Rz_1 \cdot (S_{z^2} \cdot (X_s-X_n) \cdot S_{x^2}) + Rz_2 \cdot (S_{z^2} \cdot (X_s-X_n) \cdot S_{x^2}^2)) / D.
\]

Therefore, \( \frac{dX_n^*}{dC} \geq (>) 0 \) if \( (S_{z^2} \cdot (X_s-X_n) \cdot S_{x^2^2}) \geq (>) 0 \) occurs.

Thus, \( dX_n^*/dC \geq (>) 0 \) if \( dX_n^*/dC \geq 0 \) when \( S_{z^2} \cdot (X_s-X_n) \cdot S_{x^2^2} \geq 0 \) occurs.

(Note \( S_{z^2}, S_{x^2}, R_z \) and \( D \) are positive while \( B_x, R_n, S_x \) and \( S_z \) are negative. See equations [3.2.a] through [3.2.f] above.) Q.E.D.

**Proposition 3.11**

\[
\frac{dz_1}{dr} = Rz_2 \cdot B \cdot S_r \cdot (B_x \cdot S_x + B \cdot S_{xx}) / D < 0.
\]

\[
\frac{dz_2}{dr} = \lambda \cdot Rz_1 \cdot B \cdot S_r \cdot (B_x \cdot S_x + B \cdot S_{xx}) / D < 0.
\]

\[
\frac{dX_n^*}{dr} = B^2 \cdot (\lambda \cdot Rz_1 \cdot (S_{z^2} \cdot S_{r^2} + S_{r^2} \cdot S_{z^2^2}) + Rz_2 \cdot (S_{z^2} \cdot S_{r^2} + S_{r^2} \cdot S_{z^2^2})) / D.
\]

Therefore, \( \frac{dX_n^*}{dr} \geq (>) 0 \) if \( S_{z^2} \cdot S_{r^2} \cdot S_{x^2} \geq (>) 0 \) occurs.

Thus, \( dX_n^*/dr \geq 0 \) if \( dX_n^*/dr \geq 0 \) when \( S_{z^2} \cdot S_{r^2} \cdot S_{x^2} \geq 0 \) occurs.

(Note \( S_{r^2}, S_{z^2}, S_{r^2}, R_z \) and \( D \) are positive while \( B_x, R_n, S_x, S_r \) and \( S_z \) are negative.) Q.E.D.
APPENDIX C

NOTATION

U(•): owner's utility function;
U'(•) = ∂U(•)/∂• > 0 and U''(•) = ∂²U(•)/∂•² ≤ 0.

λ: owner's loss due to GAAP deviation.

w: owner's wealth in the absence of GAAP deviation loss.

k₁: owner's litigation costs recoverable in the case of winning a potential law-suit.

k₂: owner's litigation costs irrecoverable even in the case of winning a potential law-suit.

z: z ∈ Z, set of all possible GAAP deviations; Z = [0, ∞).

z*: GAAP deviation whose size is selected as the owner's critical value for his litigation decision; z* ∈ Z.

B: auditor's expected economic loss in the case of losing a potential law-suit.

C: cost of a unit of audit care; C < B.

X: X (or x) ∈ X, set of audit care levels used by the auditor;
X (or x) > 0.

Xₛ: standard level of audit care determined by GAAS; Xₛ ∈ X.

Xₙ: substandard level of audit care; Xₙ < Xₛ, Xₙ ∈ X.

f(z|x): probability function of GAAP deviation of size, z, being discovered ex-post given that an audit care level, x, was used; continuous and differentiable; fx(z*|x) = ∂f/∂x < 0.

F(z|x): cumulative distribution function of f(z|x);
F(z*|x) = probability of GAAP deviation of size up to z* being discovered ex-post given x level of audit care = probability of an auditor's not being sued;
Fx = ∂F/∂x > 0 and Fxx = ∂²F/∂x² < 0.

R(z|Xₙ, Xₛ): f(z|Xₙ)/f(z|Xₛ); Rₙ = ∂R/∂Xₙ < 0, Rₛ = ∂R/∂Xₛ > 0, and Rz* = ∂R/∂z* > 0.

-75-
Figure 1: Uniform and Mixed Equilibria
Figure 2: An Auditor's Expected Profit Function
[Case A] Select $X_a^* > X_s$.

[Case B] Select $X_a^* = X_s$.

Figure 3: Different Cases for an Auditor's Expected Profit Function
Different Cases for an Auditor's Expected Profit Function
(Figure 3 continued)
APPENDIX E  

Supporting Work for the Numerical Example

Recall \( f = f(z|x) = x \cdot \exp(-z \cdot x) \), where \( x > 0, z > 0 \). Then,
\[
f_x = \frac{\partial f}{\partial x} = (1 - z \cdot x) \cdot \exp(-z \cdot x) \quad (f_x < 0 \text{ if } z \cdot x > 1).
\]
\[
F(z|x) = \int_0^z x \cdot \exp(-t \cdot x) dt = 1 - \exp(-z \cdot x).
\]

\[
F_x = F_x(z|x) = \frac{\partial F}{\partial x} = z \cdot \exp(-z \cdot x). \quad \text{(Note } F_x > 0.)
\]
\[
F_{xx} = \frac{\partial^2 F}{\partial x^2} = -z^2 \cdot \exp(-z \cdot x). \quad \text{(Note } F_{xx} < 0.)
\]

\[
R(z|X_s,X_n) = \frac{X_n \cdot \exp(-z \cdot X_n)/(X_s \cdot \exp(-z \cdot X_s))}{(X_n/X_s) \cdot \exp(z(X_s-X_n))} \quad \text{= } \frac{(X_n/X_s) \cdot \exp(z(X_s-X_n))}{(X_n/X_s) \cdot \exp(z(X_s-X_n))}.
\]
\[
R_z = \frac{\partial R}{\partial z} = (X_s-X_n)/(X_n/X_s) \cdot \exp(z(X_s-X_n)). \quad \text{(Note } R_z > 0.)
\]
\[
R_s = \frac{\partial R}{\partial X_s} = -\exp(z(X_s-X_n)) \cdot X_n/X_s^2 + z \cdot (X_n/X_s) \cdot \exp(z(X_s-X_n))
\]
\[
= (-1+z \cdot X_s) \cdot \exp(z(X_s-X_n)) \cdot X_n/X_s^2. \quad \text{(Note } R_s > 0 \text{ if } z \cdot x > 1).
\]
\[
R_n = \frac{\partial R}{\partial X_n} = \exp(z(X_s-X_n))/X_s - z \cdot \exp(z(X_s-X_n)) \cdot (X_n/X_s)
\]
\[
= (1-z \cdot X_n) \cdot \exp(z(X_s-X_n))/X_s^2. \quad \text{(Note } R_n < 0 \text{ if } z \cdot x > 1).
\]

Let \( S \) denote the probability of a negligent auditor's being sued.
\[
S = (1-r)\{1-F(z_1|x=X_n)\} + r\{1-F(z_2|x=X_n)\}
\]
\[
= (1-r) \cdot \exp(-z_1 \cdot X_n) + r \cdot \exp(-z_2 \cdot X_n), \quad \text{where } r < 1.
\]

\[
S_r = \frac{\partial S}{\partial r} = -\exp(-z_1 \cdot X_n) + \exp(-z_2 \cdot X_n). \quad \text{(Note } S_r < 0 \text{ since } z_1 < z_2.)
\]
\[
S_{z_1} = \frac{\partial S}{\partial z_1} = -X_n \cdot (1-r) \cdot \exp(-z_1 \cdot X_n).
\]
\[
S_{z_2} = \frac{\partial S}{\partial z_2} = -X_n \cdot r \cdot \exp(-z_2 \cdot X_n). \quad \text{(Note } S_{z_1}, S_{z_2} < 0.)
\]
\[
S_n = \frac{\partial S}{\partial X_n} = -z_1 \cdot (1-r) \cdot \exp(-z_1 \cdot X_n) - z_2 \cdot r \cdot \exp(-z_2 \cdot X_n). \quad \text{(Note } S_n < 0.)
\]
\[
\frac{\partial^2 S}{\partial x^2} = -(1-r)Fxx(z_1|x) - rFxx(z_2|x).
\]
(Note \(Sxx > 0\) since \(Fxx < 0\).

\[
\frac{\partial S}{\partial r} = z_1 \cdot \exp(-z_1 \cdot X_n) - z_2 \cdot \exp(-z_2 \cdot X_n). \quad \text{(Sign is ambiguous.)}
\]

\[
\frac{\partial^2 S}{\partial x \partial z_1} = -(1-r) \cdot \exp(-z_1 \cdot X_n) + z_1 \cdot X_n \cdot (1-r) \cdot \exp(-z_1 \cdot X_n)
= (-1+z_1 \cdot X_n) \cdot (1-r) \cdot \exp(-z_1 \cdot X_n).
\]

\[
\frac{\partial^2 S}{\partial x \partial z_2} = -r \cdot \exp(-z_2 \cdot X_n) + z_2 \cdot X_n \cdot r \cdot \exp(-z_2 \cdot X_n)
= (-1+z_2 \cdot X_n) \cdot r \cdot \exp(-z_2 \cdot X_n). \quad \text{(Snz_1, Snz_2 > 0 if } z \cdot X_n > 1.)
\]
(cf. Main Text.)
### Table 1
The Effects of the Standard (Xs)

\[
r = 0.40, \quad C = 30.0
\]

<table>
<thead>
<tr>
<th>Xs</th>
<th>(z_1)</th>
<th>(z_2)</th>
<th>(Xn^*)</th>
<th>(e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>11.1521</td>
<td>11.8600</td>
<td>0.6620</td>
<td>7.019%</td>
</tr>
<tr>
<td>0.80</td>
<td>10.3657</td>
<td>11.0235</td>
<td>0.7053</td>
<td>7.026%</td>
</tr>
<tr>
<td>0.85</td>
<td>9.6767</td>
<td>10.2908</td>
<td>0.7486</td>
<td>7.033%</td>
</tr>
<tr>
<td>0.90</td>
<td>9.0685</td>
<td>9.6439</td>
<td>0.7918</td>
<td>7.041%</td>
</tr>
<tr>
<td>0.95</td>
<td>8.5278</td>
<td>9.0689</td>
<td>0.8349</td>
<td>7.048%</td>
</tr>
<tr>
<td>1.00</td>
<td>8.0442</td>
<td>8.5546</td>
<td>0.8780</td>
<td>7.054%</td>
</tr>
<tr>
<td>1.05</td>
<td>7.6093</td>
<td>8.0920</td>
<td>0.9211</td>
<td>7.061%</td>
</tr>
</tbody>
</table>
Graph 1

The Effect of the Standard (Xs) on z*'s

[ r = 0.40, C = 30.0 ]
Graph 2

The Effect of the Standard (Xs) on Xn*

\[ r = 0.40, \ C = 30.0 \]
Graph 3

The Effect of the Standard (Xs) on e

\[ r = 0.40, \quad C = 30.0 \]
Table 2
The Effects of Audit Cost (C)
\[ X_s = 0.80, \ r = 0.40 \]

<table>
<thead>
<tr>
<th>C</th>
<th>( z_1 )</th>
<th>( z_2 )</th>
<th>( Xn^* )</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.0</td>
<td>10.6779</td>
<td>11.3544</td>
<td>0.7081</td>
<td>6.998%</td>
</tr>
<tr>
<td>26.0</td>
<td>10.5668</td>
<td>11.2363</td>
<td>0.7071</td>
<td>7.008%</td>
</tr>
<tr>
<td>28.0</td>
<td>10.4638</td>
<td>11.1268</td>
<td>0.7062</td>
<td>7.016%</td>
</tr>
<tr>
<td>30.0</td>
<td>10.3679</td>
<td>11.0248</td>
<td>0.7053</td>
<td>7.025%</td>
</tr>
<tr>
<td>32.0</td>
<td>10.2780</td>
<td>10.9293</td>
<td>0.7045</td>
<td>7.033%</td>
</tr>
<tr>
<td>34.0</td>
<td>10.1935</td>
<td>10.8395</td>
<td>0.7037</td>
<td>7.041%</td>
</tr>
<tr>
<td>36.0</td>
<td>10.1137</td>
<td>10.7547</td>
<td>0.7030</td>
<td>7.048%</td>
</tr>
</tbody>
</table>
Graph 4
The Effect of Audit Cost (C) on $z^*$'s

$[X_s = 0.80, \ r = 0.40]$
Graph 5

The Effect of Audit Cost (C) on $X_n^*$

[ $X_s = 0.80$, $r = 0.40$ ]
Graph 6
The Effect of Audit Cost (C) on $e$

$[ X_s = 0.80, \; r = 0.40 ]$
Table 3
The Effects of Risk Aversion (r)
[Xs = 0.80, C = 30.0]

<table>
<thead>
<tr>
<th>r</th>
<th>z₁</th>
<th>z₂</th>
<th>Xn*</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.30</td>
<td>10.4282</td>
<td>11.0856</td>
<td>0.70537</td>
<td>6.991%</td>
</tr>
<tr>
<td>0.35</td>
<td>10.3984</td>
<td>11.0555</td>
<td>0.70534</td>
<td>7.007%</td>
</tr>
<tr>
<td>0.40</td>
<td>10.3679</td>
<td>11.0249</td>
<td>0.70532</td>
<td>7.025%</td>
</tr>
<tr>
<td>0.45</td>
<td>10.3367</td>
<td>10.9936</td>
<td>0.70530</td>
<td>7.043%</td>
</tr>
<tr>
<td>0.50</td>
<td>10.3048</td>
<td>10.9616</td>
<td>0.70529</td>
<td>7.062%</td>
</tr>
<tr>
<td>0.55</td>
<td>10.2722</td>
<td>10.9289</td>
<td>0.70528</td>
<td>7.082%</td>
</tr>
<tr>
<td>0.60</td>
<td>10.2388</td>
<td>10.8955</td>
<td>0.70528</td>
<td>7.103%</td>
</tr>
<tr>
<td>0.65</td>
<td>10.2046</td>
<td>10.8614</td>
<td>0.70529</td>
<td>7.125%</td>
</tr>
<tr>
<td>0.70</td>
<td>10.1695</td>
<td>10.8263</td>
<td>0.70531</td>
<td>7.148%</td>
</tr>
</tbody>
</table>
Graph 7
The Effect of Risk Aversion (r) on z*'s

[ Xs = 0.80, C = 30.0 ]
Graph 8
The Effect of Risk Aversion (r) on $X_{n*}$

[ $X_s = 0.80$, $C = 30.0$ ]
Graph 9

The Effect of Risk Aversion \((r)\) on \(e\)

\([ Xs = 0.80, \ C = 30.0 \] \)
BIBLIOGRAPHY


